# RAILWAY MECHANICAL ENGINEER

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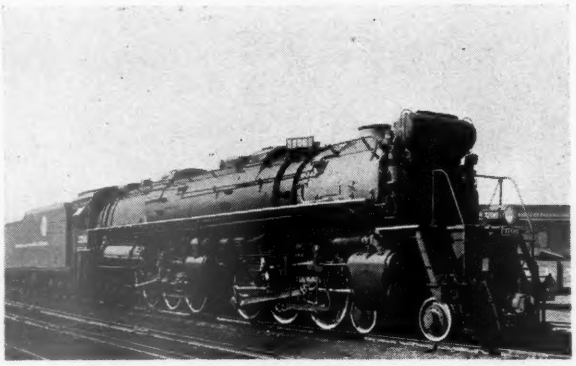
*With which are also incorporated the National Car Builder, American Engineer and Railroad Journal, Railway Master Mechanic, and Boiler Maker and Plate Fabricator. Name Registered, U. S. Patent Office.*

*See page 323*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## September, 1938

*Volume 112* *No. 9*


### Locomotives:



### General:



### Editorials:





### Back Shop and Enginehouse:



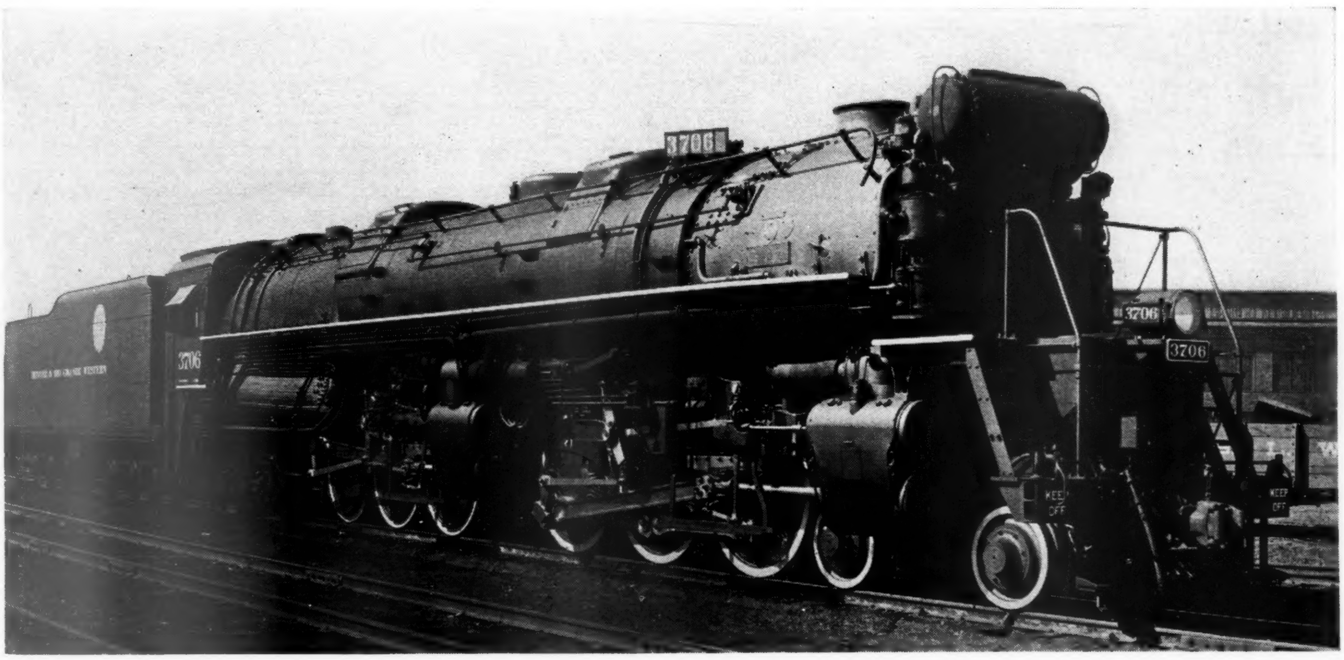
### Car Foremen and Inspectors:


Threaded
Stamina for
Vital Parts

**RAILWAY MECHANICAL ENGINEER**

**Ten 4-6-6-4 Single Expansion, Articulated**

# D. & R. G. W. Locomotives



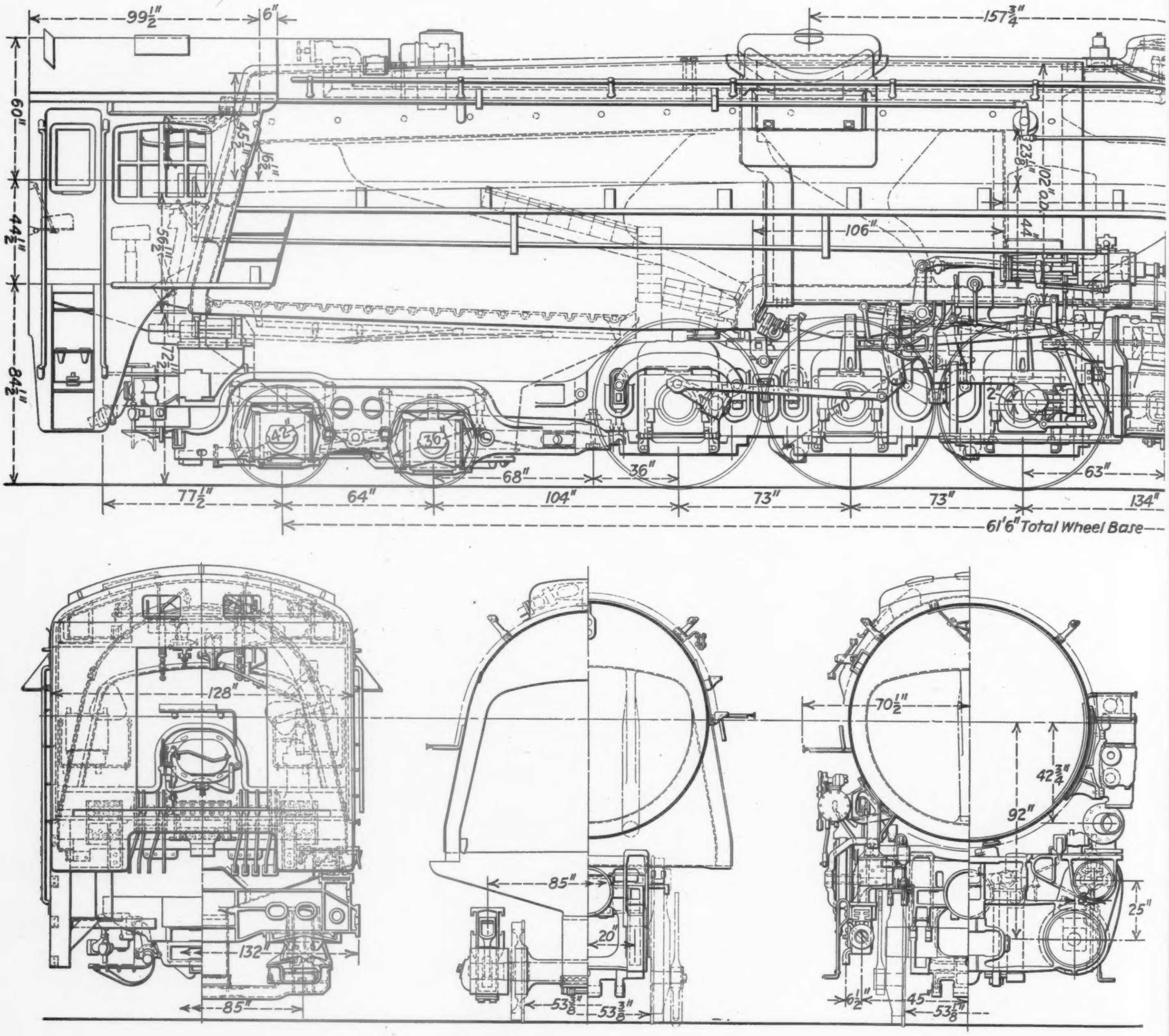

**New motive power for fast-freight service is first of its type on that road — Design is featured by large boiler, 70-in. diameter drivers and 105,000-lb. tractive force**

Recently the Baldwin Locomotive Works completed, at its Eddystone, Pa. plant, ten single-expansion, articulated, 4-6-6-4 type locomotives for the Denver & Rio Grande Western which are designed for fast-freight service. These locomotives are now operating between Grand Junction, Colo. and Salt Lake City, Utah, a distance of 295 miles and also between Grand Junction and Minturn, Colo., a distance of 148 miles. In the Grand Junction-Salt Lake City territory the line rises to a maximum elevation of 7,440 ft. above sea level and maximum grades of 2.40 per cent are encountered westbound and 2.0 per cent eastbound. The rating for these locomotives on the westbound run is 2,750 adjusted tons and average speeds of 32 to 34 m. p. h. are maintained except over the ruling grade of 2.40 per cent where helpers are used. On the eastbound run the same tonnage is handled at 38 m. p. h. except over 29 miles of 2.0 per cent grade where helpers are used. In the Grand Junction-Minturn territory the maximum elevation reached is 3,242 ft., with 1.42 per cent grades and 12-deg. curves.

The locomotives are designed for service on grades up to three per cent and operating curves of 16 deg. The design, however, is laid out for a 22-deg. curve. In spite of their size these locomotives have a rigid wheel base of only 12 ft. 2 in., thereby providing greater flexibility than many smaller units. The driving-wheel diameter is 70 in. and the rated tractive force in 105,000 lb.

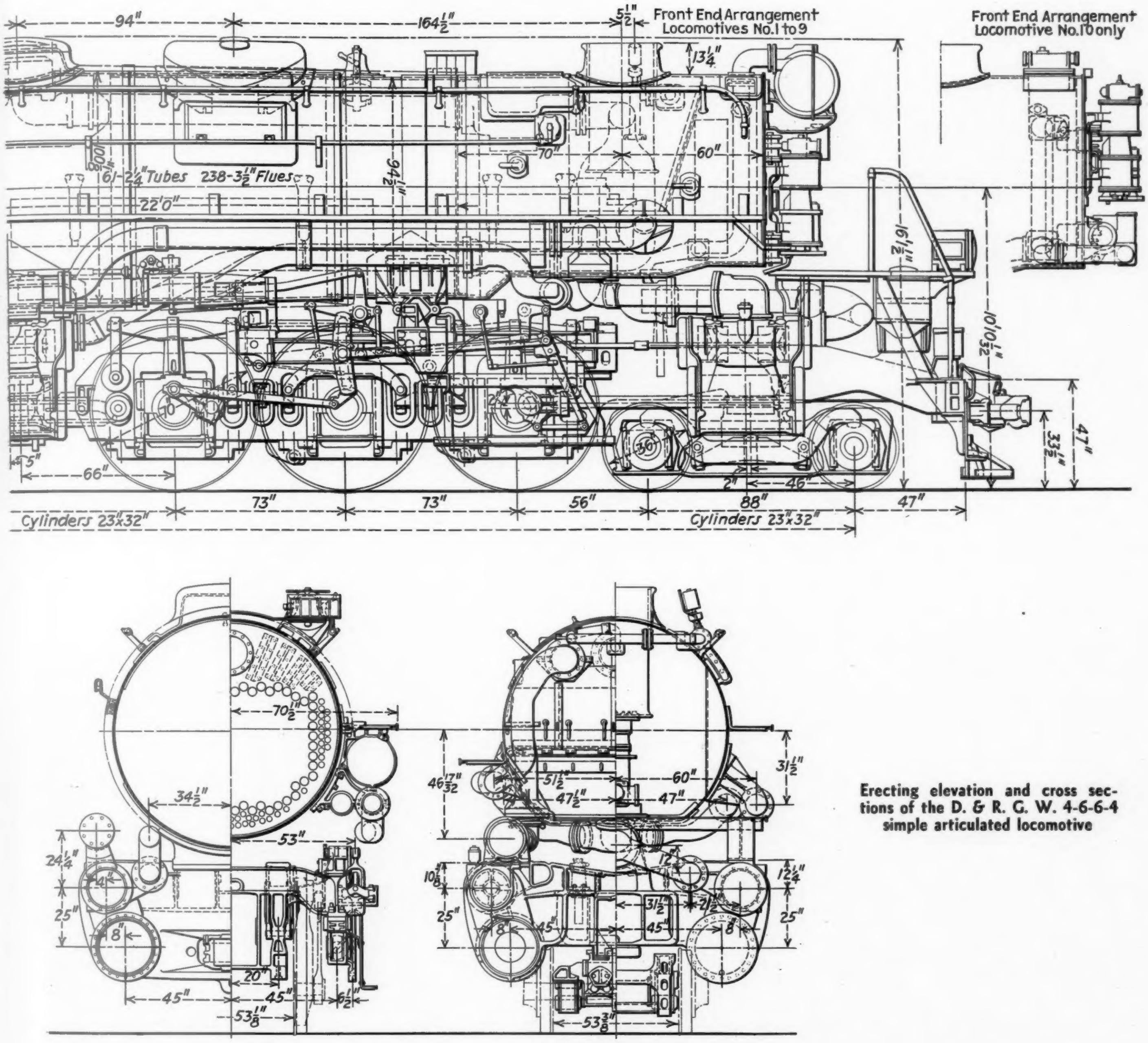
### The Boiler

The boilers on these locomotives are of especial interest because of their size, having an overall length of 61 ft. 6½ in. They are designed to burn coal and have a straight-top taper-bottom barrel of four courses, including the combustion-chamber course. The steam dome is located on the course ahead of the combustion chamber. The outside diameter of the first ring behind




### General Dimensions, Weights and Proportions of the Denver & Rio Grande Western 4-6-6-4 Type Locomotives

| | |
|---|---|
| Railroad | D. & R. G. W. |
| Builder | Baldwin |
| Type of locomotive | 4-6-6-4 |
| Road class | L-105 |
| Road numbers | 3700-3709 |
| Date built | April, 1938 |
| Service | Freight |
| **Dimensions:** | |
| Height, max., in. | 193½ |
| Height to center of boiler, in. | 130 1/32 |
| Width overall, in. | 141 |
| Cylinder centers, in. | 90 |
| **Weights in working order, lb.:** | |
| On drivers | 437,939 |
| On front truck | 84,550 |
| On trailing truck | 119,411 |
| Total engine | 641,900 |
| Tender | 394,000 |
| **Wheel bases, ft. and in.:** | |
| Driving | 35—6 |
| Rigid | 12—2 |
| Engine, total | 61—6 |
| Engine and tender, total | 108—0 |
| **Wheels, diameter outside tires, in.:** | |
| Driving | 70 |
| Front truck | 36 |
| Trailing truck, front | 36 |
| Trailing truck, back | 42 |
| **Engine:** | |
| Cylinders, number, diameter and stroke, in. | 4—23 x 32 |
| Valve gear, type | Walschaert |
| Valves, piston type, size, in. | 14 |
| Maximum travel, in. | 7¼ |
| Steam lap, in. | 1⅜ |
| Lead, in. | ⅜ at 25 per cent; 0 at full cut-off |
| Max. cut-off, per cent | 86.2 |
| **Boiler:** | |
| Type | Wagon bottom |
| Steam pressure, lb. per sq. in. | 255 |
| Diameter, first ring, inside, in. | 92¾ |
| Diameter, largest, outside, in. | 102 |
| Firebox, length, in. | 224¼ |
| Firebox, width, in. | 108¼ |
| Height mud ring to crown sheet, back, in. | 73 |
| Height mud ring to crown sheet, front, in. | 85¼ |
| Combustion chamber length, in. | 109½ |
| Thermic syphons, number | 3 |
| Tubes, number and diameter, in. | 61—2¼ |
| Flues, number and diameter, in. | 238—3½ |
| Length over tube sheets, ft. and in. | 22—0 |
| Fuel | Coal |
| Stoker | Standard Model B |
| Grate area, sq. ft. | 136.5 |
| **Heating surfaces, sq. ft.:** | |
| Firebox and comb. chamber | 613 |
| Thermic syphons | 165 |
| Firebox, total | 778 |
| Tubes and flues | 5,563 |
| Evaporative, total | 6,341 |
| Superheating | 2,628 |
| Combined evap. and superheat | 8,969 |
| **Tender:** | |
| Style | Rectangular |
| Water capacity, gal. | 20,000 |
| Fuel capacity, tons | 26 |
| Trucks | 6-wheel |
| Rated tractive force, engine, 85 per cent, lb. | 105,000 |




Erecting elevation and cross sections of the D. & R. G. W. 4-6-6-4 simple articulated locomotive

| | |
|---|---|
| Weight proportions: | |
| Weight on drivers ÷ weight engine, per cent | 68.3 |
| Weight on drivers ÷ tractive force | 4.17 |
| Weight of engine ÷ evaporative heat. surface | 101.2 |
| Weight of engine ÷ comb. heat. surface | 71.6 |
| Boiler proportions: | |
| Firebox heat. surface, per cent comb. heat. surface | 8.67 |
| Tube-flue heat. surface, per cent comb. heat. surface | 62.4 |
| Superheat. surface, per cent comb. heat. surface | 29.3 |
| Firebox heat. surface ÷ grate area | 5.70 |
| Tube-flue heat. surface ÷ grate area | 40.8 |
| Superheat. surface ÷ grate area | 19.3 |
| Comb. heat. surface ÷ grate area | 65.7 |
| Evaporative heat. surface ÷ grate area | 46.6 |
| Tractive force ÷ grate area | 781.0 |
| Tractive force ÷ evaporative heat. surface | 16.6 |
| Tractive force ÷ comb. heat. surface | 11.7 |
| Tractive force × diameter drivers ÷ comb. heat. surface | 819.0 |

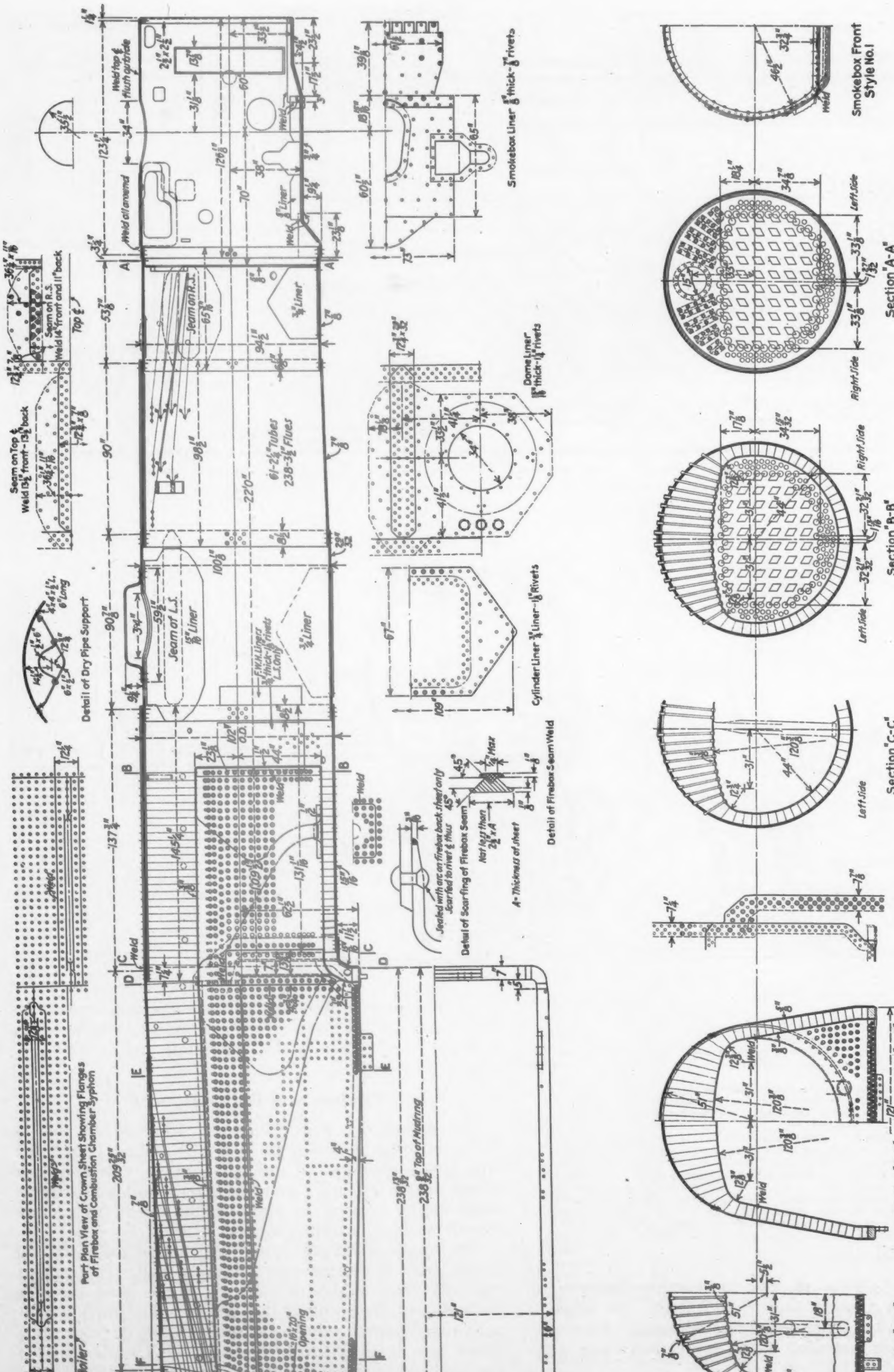
the smokebox is 94½ in. and the outside diameter of the combustion-chamber course is 102 in., the slope in the bottom of the boiler being in the second course in order to provide sufficient water space under the combustion chamber.

The boiler shell is made of silicon-manganese steel, this material also being used for the outside wrapper and outside side sheets, shell liners and welt strips. The horizontal seams are butt joints multiple-riveted with inside and outside welts. The combustion chamber has a height of 67⅛ in. on the center line and is 109½ in. long.

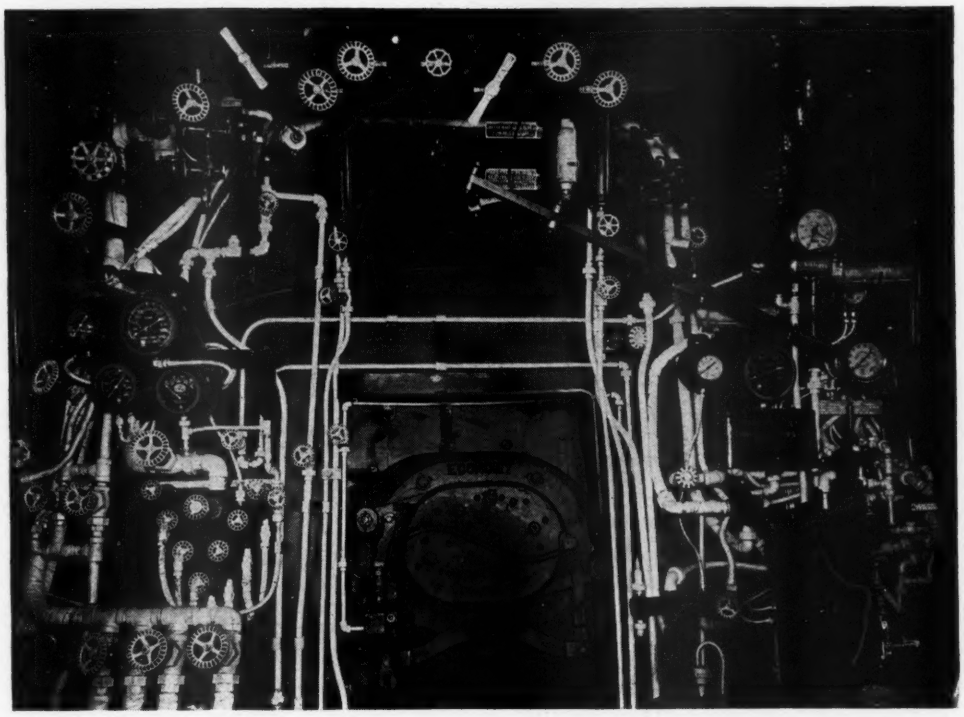
### Firebox and Boiler Details

The firebox has a grate area of 136.5 sq. ft. and is 224¼ in. long by 108¼ in. wide. Rosebud (pin-hole) type grates are used. The firebox crown, side and back sheets are ⅜ in. thick and the crown and sides are in three sheets. All of the seams in the inside firebox are electric welded, except the door sheet.

The length of the grates is 182 in. and at the front end of the grate is a transverse fire-brick wall. In front of this wall there is a cinder hopper, in the space between the wall and the front of the firebox. The firebox contains two Thermic syphons which support the brick arch. There is a third Thermic syphon on the center line of the combustion chamber. An extensive application of flexible stays is embodied in the firebox and combustion chamber, this type of staybolt being applied as a complete installation in the throat sheet and combustion




Boiler elevation, cross sections and details



Arrangement of the cab fittings and piping

chamber, in the two outside rows on the back head, and in the breaking zone of the side sheets. Across the front end of the crown sheet there are four rows of expansion stays. The staybolt installation on the firebox and combustion chamber includes 72 expansion stays, 158 radials and 1,923 flexible stays. All flexible sleeves are welded to the sheets.

The grate is divided into three longitudinal sections, with three shaker bars to each section. Coal is distributed to the grates by a Standard modified Type B stoker having seven control valves. The stoker engine is located on the tender. The ash pan is of steel-plate construction and has two large hoppers with air-operated slides.

The boilers are fitted with 61 2¼-in. tubes and 238 3½-in. flues. The length over the tube sheets is 22 ft. Tubes and flues are welded to the back tube sheet.

The boilers are equipped with Type E superheaters with Tangential steam dryers. Saturated steam passes through a 12-in. steel drypipe to the superheater header. The steam flow to the cylinders is controlled by an American multiple type front-end throttle. The boilers are equipped with the Elesco feedwater heater on nine of the locomotives and the Worthington heater on one locomotive. The Elesco heaters are located on the front of the smoke-box, above the air compressors, with the feedwater pump on the left side of the locomotive. In the case of the Worthington heater, it is placed in the top of the smokebox ahead of the stack, with the cold-water pump on the left side close to the tender and the hot-water pump on the smokebox front below the door. Each locomotive is equipped with one Hancock non-lifting, Type K-NL injector of 12,000 gallons capacity. The injector is located on the right side.

### Engine Beds and Machinery

Each of the two separate units of these locomotives has its own one-piece bed casting furnished by the General Steel Castings Corporation, in which the cylinders are cast as an integral part. They are fitted with articulated hinge connections equipped with the Cardwell-Westinghouse friction draft gear to permit movement between the units of about 1 in. longitudinally.

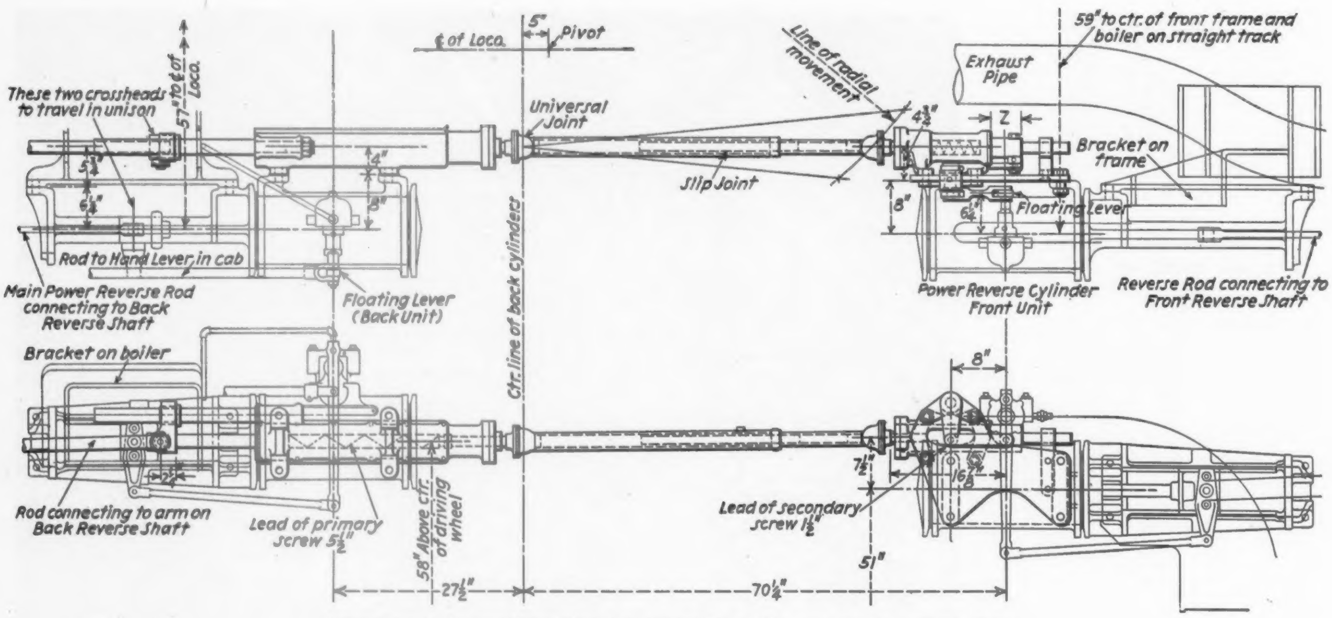
The cylinders, four in number, are 23 in. bore by 32 in. stroke and are 90 in. between centers. The cylinder barrels are strengthened by a continuous rib 1½ in. wide between the front and back stud flanges which also serves as a jacking strip. The steam distribution is effected by a 14-in. piston valve actuated by the Walschaert valve gear. The cylinder and valve bushings and valve packing rings are of Hunt-Spiller gun iron. The cylinder cocks, cylinder drain valves and cylinder-cock operating valves are of Okadee design. The cylinder heads are of cast steel. The piston heads are of nickel cast steel fitted with packing rings of copper-tin bronze. The piston rods are 5 in. in diameter, of carbon steel.

The guides are of the multiple-bearing type with the Alco Slidguide connection to the back cylinder head.

These locomotives are equipped with an arrangement for providing variable lead similar to that applied to a group of 4-8-4 type locomotives* built for the D. & R. G. W. in 1929. The front end of the radius rod is fixed to a block which moves vertically in a slide in the upper end of the combination level. This block is suspended from a bell crank connected to the reverse shaft by a reach rod. The movement of this block effects a change in the length of the combination lever so that the lead may be increased from zero in full gear to ⅜ in. at 25 per cent cut-off. The maximum valve travel is 7¼ in.

The valve gear is controlled by two Baldwin Type C power reverse bears, one for the front unit located on a bracket cast on the bed and another for the rear unit supported on the boiler. Synchronous control of the two valve gears is effected by means of a connection between the reverse shaft on the rear unit and the floating lever of the reverse gear operating the forward valve motion, this action being fitted with two universal joints and one slip joint which permit it to accommodate itself to the swing of the front unit when negotiating curves. By means of this arrangement identical cut-offs on both front and rear units are possible. This arrangement for controlling the valve gears is covered by patent applica-

* Described on page 621 of the October, 1929, issue of the *Railway Mechanical Engineer*.




**Arrangement for synchronizing the operation of the two power reverse gears**

tion. In order to effect the most economical handling of the Valve Pilot has been applied.

The driving-wheel centers on these locomotives are 63 in. diameter and are the Baldwin cast-steel disc type. The material in the driving-wheel centers is special high-tensile steel. The diameter of the drivers, outside the tires is 70 in. All of the driving-wheel tires are flanged. The driving axles are of hammered carbon steel and are equipped with SKF roller bearings. The total lateral allowed on driving boxes is 3/16 in. Forty per cent of the reciprocating weight is balanced and the main wheels are cross balanced. The main and side rods and crank pins are of carbon steel. The main rods are connected to the third pair of wheels on each unit and all crank pins are fitted with floating bushings.

The front engine truck, furnished by the General Steel Castings Corporation, is designed for a truck swing of 6 in. each side of the center line. The engine-truck axles are fitted with A. S. F. roller-bearing units. The rear truck is of the Delta type and is also fitted with A. S. F. roller-bearing units. It is designed to swing 8½ in. on each side of the center line at the rear wheel. The lateral allowed on the engine-truck-wheel bearings is 3/16 in. total. At the front bearing of the rear truck ⅜ in. total lateral is allowed and at the rear wheels, ¼ in.

The couplers at the front end of the engine and at the rear of the tender are Type E furnished by the National Malleable and Steel Castings Company. A Franklin friction radial buffer is used between the engine and tender together with the Unit Safety drawbar.

The cab is of the vestibule type, of steel plate with all seams welded; it is lined with wood. Polished plate glass is used throughout the windows. The front and back windows, through which the crew is required to

### Partial List of Materials and Equipment on the Denver & Rio Grande Western 4-6-4-4 Type Locomotives

| | |
|---|---|
| Frames; engine-bed castings; trucks | General Steel Castings Corp., Eddystone, Pa. |
| Wheels, front truck | Standard Steel Works Co., Burnham, Pa. |
| Wheels, trailer truck | Carnegie-Illinois Steel Corp., Pittsburgh, Pa. |
| Wheel centers, disc type | Standard Steel Works Co., Burnham, Pa. |
| Tires, driving wheel | American Locomotive Co., New York |
| Axles, driving and trailer truck | Standard Steel Works Co., Burnham, Pa. |
| Springs, truck | American Steel Foundries, Chicago |
| Bearings, driving-wheel | SKF Industries, Philadelphia, Pa. |
| Bearings, engine and trailer truck | American Steel Foundries, Chicago |
| Slidguide attachment | American Locomotive Co., New York |
| Air brake equipment | Westinghouse Air Brake Co., Wilmerding, Pa. |
| Driver brake | American Brake Co., St. Louis, Mo. |
| Brake shoes | American Brake Shoe & Foundry Co., New York |
| Drawbar and radial buffer | Franklin Railway Supply Co., Inc., New York |
| Coupler | National Malleable and Steel Castings Co., Cleveland, Ohio |
| Piston rods | Standard Steel Works, Burnham, Pa. |
| Piston-rod packing | Paxton-Mitchell Co., Omaha, Neb. |
| Piston-valve packing rings | Hunt-Spiller Manufacturing Corporation, Boston, Mass. |
| Air-pump packing | Johns-Manville Sales Corp., New York |
| Air-pump lubricator | Westinghouse Air Brake Co., Wilmerding, Pa. |
| Mechanical lubricators | Detroit Lubricator Co., Detroit, Mich.<br>Ohio Injector Co., Wadsworth, Ohio |
| Cylinder valves and cocks | The Okadee Company, Chicago |
| Cylinder and valve bushings | Hunt-Spiller Manufacturing Corporation, Boston, Mass. |
| Crank pins | Standard Steel Works Co., Burnham, Pa. |
| Crosshead pin lubrications | Alemite Div. Stewart-Warner Corp., Chicago |
| Valve pilot | Valve Pilot Corporation, New York |
| Reverse gear | The Baldwin Locomotive Works, Philadelphia, Pa. |
| Firebox steel | Carnegie-Illinois Steel Corp., Pittsburgh, Pa. |
| Lagging | Johns-Manville Sales Corp., New York |
| Jacket iron | Armco Railroad Sales Co., Middletown, Ohio |
| Staybolt iron | Joseph T. Ryerson & Son, Inc., Chicago<br>Ewald Iron Co., Louisville, Ky. |
| Brick arch | American Arch Co., Inc., New York |
| Tubes | National Tube Co., Pittsburgh, Pa. |
| Thermic syphons | Locomotive Firebox Co., Chicago |
| Superheater, Type E, with tangential dryer | The Superheater Company, New York |
| Throttle | American Throttle Co., New York |
| Steam-pipe expansion joints | Paxton-Mitchell Co., Omaha, Neb. |
| Steam-pipe covering | Union Asbestos & Rubber Co., Chicago |
| Feedwater heater | (9) The Superheater Company, New York<br>(1) Worthington Pump and Machinery Corp., Harrison, N. J. |
| Injectors; blower valves; safety valves; steam gages | Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., Bridgeport, Conn. |
| Blow-off cocks | The Okadee Company, Chicago |
| Blower connections | Barco Manufacturing Co., Chicago |
| Steam-heat connections | Vapor Car Heating Co., Inc., Chicago |
| Air and steam gage holders | Swanson Co., Chicago |
| Stoker | Standard Stoker Co., Inc., New York |
| Sanders | Graham-White Sander Corp., Roanoke, Va. |
| Bell ringer | Railway Service and Supply Corp., Indianapolis, Ind. |
| Headlights | (5) Pyle-National Co., Chicago<br>(5) Sunbeam Electric Mfg. Co., Evansville, Ind. |
| Gage lamps | Pyle-National Co., Chicago |
| Marker lamps | The Adams & Westlake Co., Elkhart, Ind. |
| Classification lamps | Handlan, Inc., St. Louis, Mo. |
| Indicator boxes | The Adams & Westlake Co., Elkhart, Ind. |
| Cab window glass | Libbey-Owens-Ford Glass Co., Toledo, Ohio |
| Flexible joints between engine and tender | Barco Manufacturing Co., Chicago |
| Lacquer | E. I. duPont de Nemours & Co., Wilmington, Del. |
| Tender: | |
| Underframe and trucks | General Steel Castings Corp., Eddystone, Pa. |
| Tender-truck wheels and axles | Standard Steel Works Co., Burnham, Pa. |
| Roller bearings | SKF Industries, Philadelphia, Pa. |
| Springs | American Steel Foundries, Chicago |
| Spring-rigging lubrication | Alemite Div. Stewart-Warner Corp., Chicago |
| Clasp brake; coupler yoke | American Steel Foundries, Chicago |
| Coupler | National Malleable and Steel Castings Co., Cleveland, Ohio |
| Draft gear | Cardwell Westinghouse Co., Chicago |
| Tank bottom | General Steel Castings Corp., Eddystone, Pa. |
| Hose strainer | The Okadee Company, Chicago |


Front end showing feedwater heater and air compressors

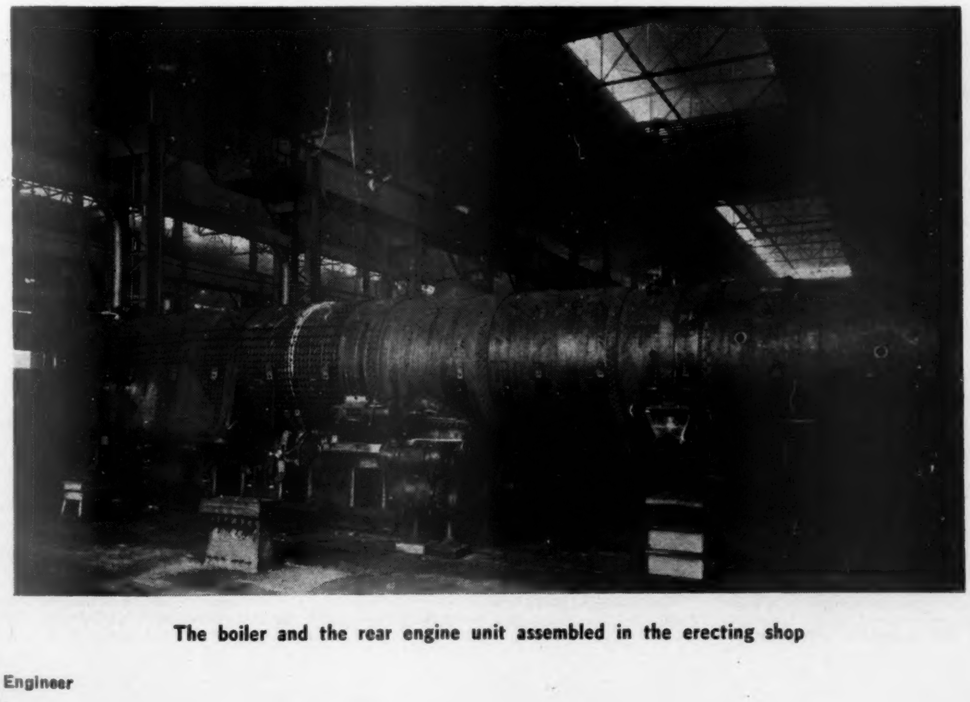
look, are $\frac{3}{16}$ in. thick and the others are $\frac{1}{8}$ in. thick.

The Westinghouse No. 8ET air-brake equipment is used on all driving and tender wheels. The American Brake Company's foundation brake is used on the drivers. Two 8½-in. cross-compound air compressors are mounted on the smokebox front. The main and auxiliary reservoirs, cast in the rear engine bed, have a combined capacity of 29,000 cu. in. and two additional reservoirs under the left running board provide an additional 72,600 cu. in., making a total of 101,600 cu. in. reservoir capacity. The Le Chatelier water brake, used on the D. & R. G. W., is also applied to these locomotives. The headlight equipment on five of the locomotives was furnished by Pyle-National and on the remaining five by Sunbeam. Each engine unit has a sandbox with 20 cu. ft. capacity and the sand is distributed by Graham-White sanders. The locomotives are fitted with air signal and steam-heat equipment so that, if desired, they may be used in passenger-train service. Barco flexible joints are used on the air signal and steam lines between the engine and tender.

### Lubrication

Locomotives of this size present an unusual problem in lubrication. On these the lubrication system comprises three types: The self-contained lubrication for the roller-bearing axle boxes on the trucks and drivers; the mechanical lubrication, under pressure, for the major parts of the machinery, and the pressure grease lubrication. The latter consists of the use of the Alemite system on rods, crosshead pins and trailer truck radius-bar seat. The mechanical lubricating system consists of six Detroit Model A lubricators of 30 pints capacity, three for each unit. Two lubricators on each unit are mounted on the left side and one on the right side and all are driven from the valve motion. Through the medium of 40 lubricator feeds, 17 two- and four-way oil dividers and 86 oil lines, the oil is fed to the valves and cylinders, main guides, valve-stem crosshead guides, lead changers, driving- and engine-truck-box pedestals, engine-truck center pin, articulated hinge pins, waist-bearer saddle, ball and expansion joints in steam and exhaust pipes and the radial buffer between the engine and tender. There is also one Chicago K-23 hydrostatic lubricator of three pints capacity in the cab for the feed-water pump and stoker engine, and flange lubricators for the leading drivers of each unit.

The tender is of the rectangular type, having a cast-steel water-bottom frame furnished by the General Steel Castings Corporation and a riveted tank. The water capacity is 20,000 gallons and the coal capacity 26 tons. The General Steel Castings six-wheel tender trucks with cast-steel frames, swing bolsters and top equalizers are used. The tender-truck axles are fitted with SKF roller bearings, The tender-truck brakes are of the clasp type furnished by the American Steel Foundries. The draft gear at the rear end of the tender is Cardwell-Westinghouse type N. Y.-11-E.



The boiler and the rear engine unit assembled in the erecting shop

**Fall Meetings of**

# Mechanical Associations

MEETINGS of three mechanical associations and an executive committee meeting of a fourth will be held at the Hotel Sherman, Chicago, on September 27-28. Full programs of papers and committee reports, as shown below, will be presented by the Car Department Officers' Association, the Railway Fuel and Traveling Engineers' Association, and the Master Boiler Makers' Association.

All members of the Railway Fuel and Traveling Engineers' Association are promised advance copies of the reports ten days in advance of the meeting. The constitution will be up for adoption at this meeting, which is the second annual meeting of the new association.

The program of the Car Department Officers' Association calls for a two-day meeting in four sessions, with a full program of association business, including election of officers, as well as the reports of committees dealing with the subjects and problems of interest to officers and supervisors of the car department.

All members are being invited to attend the open business meeting of the Master Boiler Makers' Association, at which a minimum of association business will be transacted and attention centered on the discussion of the topics pertaining to locomotive boiler operation and boiler shop practice. There will be no election of officers.

A meeting of the officers and members of the executive committee of the International Railway General Foremen's Association will face the problem of the future of the association itself, as well as the proposals that places be made in it for the members and programs of the International Railway Master Blacksmiths' Association and the American Railway Tool Foremen's Association. No papers or committee reports are being presented.

## Car Department Officers Association

SEPTEMBER 27

9 a. m.

Approval of minutes of last annual meeting
Remarks by president
Report of Membership Committee
Report of secretary-treasurer
Unfinished business
New business

2 p. m.

Freight and Passenger Car Construction and Maintenance. Chairman, J. McMullen, superintendent car department, Erie
Shop Operation, Facilities and Tools. Chairman, J. A. Deppe, superintendent car department, Chicago, Milwaukee, St. Paul & Pacific
Passenger-Train-Car Terminal Handling. Chairman, G. R. Anderson, district master car builder, Chicago & North Western
Lubricants and Lubrication. Chairman, L. R. Wink, assistant superintendent car department, Chicago & North Western
Freight-Car Inspection and Preparation for Commodity Loading. Chairman, F. G. Moody, master car builder, Northern Pacific

SEPTEMBER 28

9 a. m.

Interchange. Chairman, M. E. Fitzgerald, master car builder, Chicago & Eastern Illinois
Loading Rules. Chairman, C. J. Nelson, superintendent of interchange, Chicago Car Interchange Bureau
Billing for Car Repairs. Chairman, D. E. Bell, A. A. R. instructor, Canadian National
Painting. Chairman, L. B. Jenson, passenger-car-shop superintendent, Chicago, Milwaukee, St. Paul & Pacific
Publicity. Chairman, E. L. Woodward, western editor, *Railway Mechanical Engineer*

2 p. m.

Report of Nominating Committee
Election of officers

## The Railway Fuel and Traveling Engineers' Association

SEPTEMBER 27

(Three sessions—10 a. m., 2 p. m. and 8 p. m., continuing at 9 a. m. on September 28, if necessary)

SPECIAL PAPERS

Avoidable Factors in Locomotive Design Affecting Fuel Consumption, by F. P. Roesch, vice-president, Standard Stoker Co., Inc.
The Relation of the Engineer and Fireman Towards Fuel Economy, by Harley Finberg, engineman, Northern Pacific
The Relation of the Enginehouse Foreman Towards Fuel Economy, by R. K. Thornley, enginehouse foreman, Wabash
What Can the Traveling Engineer, Fuel Supervisor and Road Foreman Do to Further Fuel Conservation?, by G. M. Boh, district road foreman engines, Erie
What May Be Done in Performance Improvement and Economy by Local (that is, Divisional) Train-by-Train Comparison of Ton-Miles Performance?, by R. S. Twogood, assistant engineer, Southern Pacific

COMMITTEE REPORTS

1—Locomotive Firing Practice—Coal. Chairman, W. C. Shove, general road foreman of engines, New York, New Haven & Hartford
  a—The responsibility of the enginehouse foreman
  b—The responsibility of the engineers
  c—The responsibility of road foremen and fuel supervisors
2—Locomotive Firing Practice—Oil. Chairman, R. S. Twogood, assistant engineer, Southern Pacific
  Suggested instructions for firing heavy oils
3—Fuel Records and Statistics. Chairman, E. E. Ramey, fuel engineer, Baltimore & Ohio
  a—Shall fuel records be based on gross ton-miles or on dollars and cents?
  b—How can the supervisor of locomotive performance and fuel conservation further aid in the improvement of railroad operation? What does he need in the way of statistics, man power and any other media to foster interest?
4—Utilization of Locomotives. Chairman, A. A. Raymond, superintendent fuel and locomotive performance, New York Central
5—Air Brakes. Chairman, W. H. Davies, superintendent air brakes, Wabash
  a—The relationship of the No. 8 ET locomotive brake equipment and train handling
  b—Arrangement and handling of high-speed passenger brake equipment
6—New Locomotive Economy Devices. Chairman, A. G. Hoppe, assistant mechanical engineer, Chicago, Milwaukee, St. Paul & Pacific
7—Steam Turbine and Steam Condensing Locomotives. Chairman, L. P. Michael, chief mechanical engineer, Chicago & North Western
8—Adoption of constitution
Election of Officers.

## Master Boiler Makers' Association

SEPTEMBER 27

10 a. m.

Address by President William N. Moore
Address and annual report by Secretary-Treasurer Albert F. Stiglmeier
Good of the association
Topic No. 1—What means can or have been suggested to improve circulatory and other conditions in the locomotive boiler to eliminate leaky stays and cracked side sheets? Chairman, C. W. Buffington, general master boiler maker, Chesapeake & Ohio
Topic No. 2—Honeycombing and slagging of flues and tubes, its cause and prevention. Chairman, Myron C. France, general boiler foreman, Chicago, St. Paul, Minneapolis & Omaha

1:30 p. m.

Topic No. 3—Which type of application of waste bearer angles or tees gives the least trouble? Chairman, Edward H. Heidel, general boiler department foreman, Chicago, Milwaukee, St. Paul & Pacific
Topic No. 4—Pitting and corrosion of locomotive boilers and tenders. Chairman, J. F. Becker, general boiler and machinery inspector, Chicago Great Western
Topic No. 5—Prevention of cinder cutting of flues and tubes, firebox sheets, steam pipes, etc. Chairman, Sigurd E. Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford
Topic No. 6—What can be done to overcome the cracking of outside throat sheets? Chairman, M. V. Milton, chief boiler inspector, Canadian National
Topic No. 7—In the application of flexible staybolts to boilers, which method gives the best results: (a) Screw the bolt up to a decided seat in the sleeve, cut to length and head over the bolt on the firebox end; (b) screw the bolt up to a decided seat in the sleeve and then turn back one-quarter turn before cutting to length and heading bolt over on the firebox end? Chairman, Leonard C. Ruber, superintendent of boiler department, Baldwin Locomotive Works
Topic No. 8—Topics for 1939 meeting. Chairman, Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis
Good of the association

**Bureau of Mines Investigation on the Intercrystalline**

# Cracking of Boiler Steel*

**By W. C. Schroeder**, A. A. Berk† and R. A. O'Brien‡**

**Progress report to the A. R. E. A. Subcommittee on Water Service, Fire Protection and Sanitation relates the present status of embrittlement investigation**

THE cracking of steel by intercrystalline attack through the action of a boiler water is one of the most dangerous ills in modern boiler operation. The cracking may progress to a considerable depth and greatly damage the metal before it becomes visible on the surface. Under the microscope cracks of appreciable length have been found that are only a few millionths of an inch wide. This difficulty in finding the cracks is coupled to further danger from the very large concentration of stress they may allow. In the laboratory it has been repeatedly found that intercrystalline cracks, invisible to the eye on the surface of the metal and extending into a ¼-in. section only a few thousandths of an inch, will allow complete fracture to occur from a very light blow with a hammer. These cracks, even when shallow, produce such a high stress concentration that any remaining sound metal is incapable of allowing a distribution of stress and therefore an apparently brittle failure occurs. This effect is not dependent on aging of the metal, but is produced by the action of the boiler water under certain definite conditions. This type of damage may be especially important in locomotive boilers since they are unquestionably subjected to more shock or impact stress than stationary boilers. Furthermore, discovery of the cracks is made difficult by the presence of the insulating jacket over the shell courses.

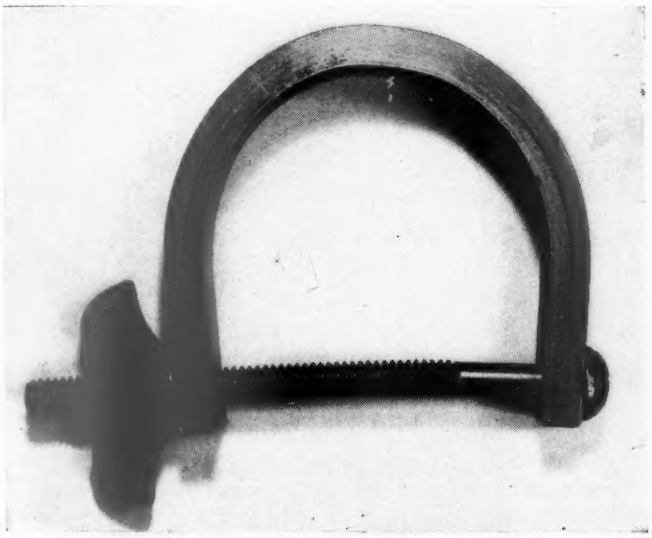


Fig. 1—U-bend specimen ready for immersion in the solution

In 1932 considerable uncertainty still existed concerning adequate methods that might be used to prevent trouble. For example, the boiler code prepared by the American Society of Mechanical Engineers indicated that sodium sulphate would stop cracking. On the other hand, considerable evidence was available to show that this was not always true, especially in locomotive operation.

Cooperative investigation between the Bureau of Mines and the Joint Research Committee on Boiler Feedwater Studies, which received major support from the Association of American Railroads, therefore attempted to establish more clearly the solution, concentration and stress factors involved in the production of intercrystalline cracks, and means that could be used to prevent them.

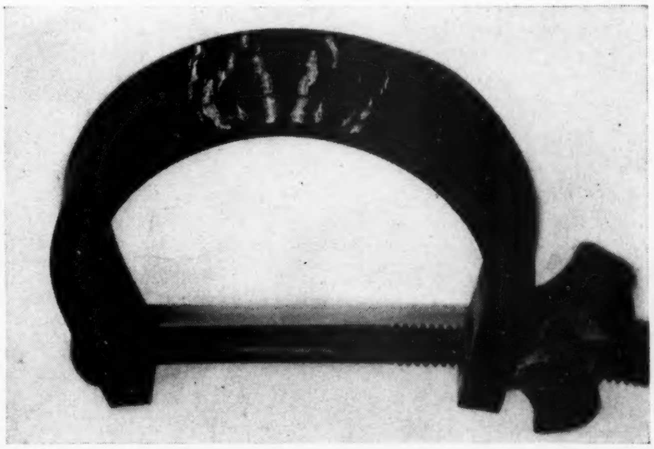


Fig. 2—U-bend specimen of cold-rolled steel broken in sodium hydroxide-sodium nitrate solution

In order to study means for preventing intercrystalline failure it was first necessary to understand how, and under what conditions, it occurred. No investigator has ever been able to produce this type of failure in normal low carbon steel by static stress at room temperature or temperatures in the boiler range; by repeated stresses, or by repeated stresses coupled with corrosion; or by the action of gases such as hydrogen. It has been necessary to have the steel in contact with certain solutions to produce intercrystalline cracking.

Two kinds of specimens were used in the laboratory

* Abstracted from Bulletin No. 404, A.R.E.A., June-July, 1938. The investigation reported in this paper was conducted under a co-operative agreement between the Joint Research Committee on Boiler Feedwater Studies and the Bureau of Mines. The Association of American Railroads is one of the major contributors. The work is carried out at the Bureau's Eastern Experiment Station at College Park, Md. The paper is published by permission of the Director of the Bureau of Mines and is not subject to copyright.

** Research chemical engineer, Joint Research Committee on Boiler Feedwater Studies, Eastern Experiment Station, Bureau of Mines, College Park, Md.

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to determine the types of solution that would produce intercrystalline or embrittlement failure. The first was a flat strip bent into the form of a U and pulled together by a bolt on the ends. This was largely used in solutions boiling under atmospheric pressure. The second was a tubular specimen closed at one end, that was put under tensile stress by a weight and lever system that will be described later. This specimen was used for tests at pressures from 50 to 1,200 lb. per sq. in.

### Action of Solutions in U-Bend Tests

Fig. 1 shows the type of specimen used for the U-bend tests. It consists of a bar of cold rolled steel ¼-in. by ½-in. bent into the shape shown. The ends are pulled together by a bolt to retain a high elastic stress in the metal.

Early investigators believed that cracking could be produced in this specimen by immersion in a concentrated sodium hydroxide, or a concentrated sodium nitrate solution boiling under atmospheric pressure. However, this did not prove to be the case when the specimen was tested for periods up to seven days in pure sodium hydroxide solutions or in periods from three to nine days in pure sodium nitrate solutions.

These early investigators probably secured cracking in their specimens because certain impurities were present in the sodium hydroxide and sodium nitrate they used. For example, Table I shows that a number of oxidizing agents may be added to the hydroxide solutions to cause rapid cracking. The lead oxide (PbO) is especially effective in this respect. Fig. 2 shows one of the specimens cracked in a concentrated sodium hydroxide solution containing a small amount of sodium nitrate. The position of the crack is outlined by the deposit of sodium carbonate resulting from the reaction of the sodium hydroxide as it seeps out of the fissure, with the carbon dioxide of the air. Some of the fine cracks may also be seen. The cracking produced in U-bend specimens by all of the solutions listed in Table I is completely intercrystalline.

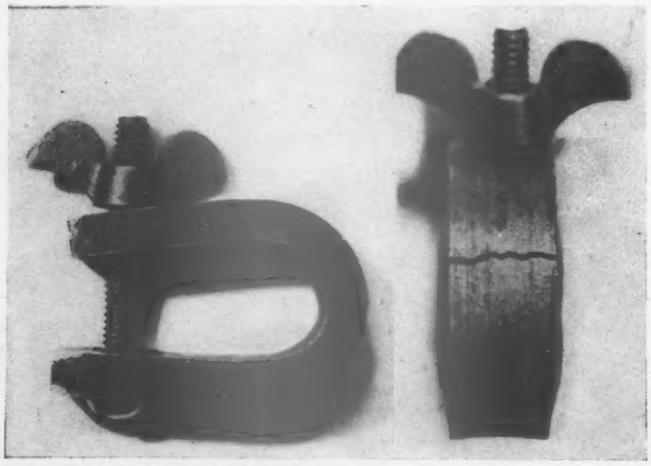


Fig. 3—U-bend specimen of boiler flange steel broken in one day by nitrate-manganese solution

It has also been found that the addition of a very small amount of manganous salt will promote the rapid cracking of steel in concentrated sodium nitrate solution. Fig. 3 shows a specimen of boiler flange steel cracked entirely through in one day in a boiling sodium nitrate solution containing a small amount of manganese.

These experiments led to the belief that intercrystalline cracks could be produced in any solution containing both a corrosive and a partially protective agent. To test this theory an attempt was made to produce cracking in a solution containing nitric acid and a manganous salt. Cracking resulted when the proper concentration and temperature conditions were found.

From these experiments with the U-bend specimens, and from many other tests that have already been reported concerning this investigation it has been possible to outline a definite mechanism that can produce this type of failure.

Steel is fundamentally a heterogeneous mass composed of minute grains or crystals. The boundaries between these grains represent material that differs physically or chemically or in both respects from the grains themselves. Ordinary or general corrosion, however, does not attack the grain boundaries preferentially.

**Table I—Oxidizing Compounds That Will Accelerate Cracking of U-Bend Specimens in Sodium Hydroxide Solutions**

Solutions boiling under atmospheric pressure

| Grams NaOH per 100 grams water | Oxidizing compound | Grams per 100 grams of water | Crack, days |
|---|---|---|---|
| 50 | $KMnO_4$ | 0.2 | 7 |
| 50 | $Na_2CrO_4$ | 0.2 | 4-7 |
| 50 | $NaNO_3$ | 0.2-1.0 | 3-5 |
| 50 | PbO | 0.2 | 1-2 |

If the general corrosion is retarded by an only partially protective film produced by the solution, it is possible to confine the attack largely to the grain boundaries. For example, the oxidizing agents listed in Table I may serve to form a protective film over the crystal or grain faces, leaving the grain boundaries relatively unprotected or exposed to the attack by the sodium hydroxide solution. If the grain boundary is highly stressed, this localized chemical attack will cut the boundary just as a sharp knife cuts a bowstring. The widening of the notch by the stress will prevent the accumulation of corrosion products from stopping further attack. Once this notch is deep enough the corrosion products in themselves will generate large stresses in the grain boundaries because they occupy a greater volume than the original material. This action is analogous to the bursting forces produced by the expansion of water as it freezes in a deep crack in a stone. The combined action of selective corrosion, grain boundary stress, and bursting forces exerted by the corrosion products would rapidly propagate the intercrystalline crack.

Fig. 4—U-bend specimen cracked without applied stress

It should be clearly understood, however, that the forces acting on the grain boundaries do not necessarily have to result from an applied load, but may arise from cold work or internal stress in the metal. This is demon-

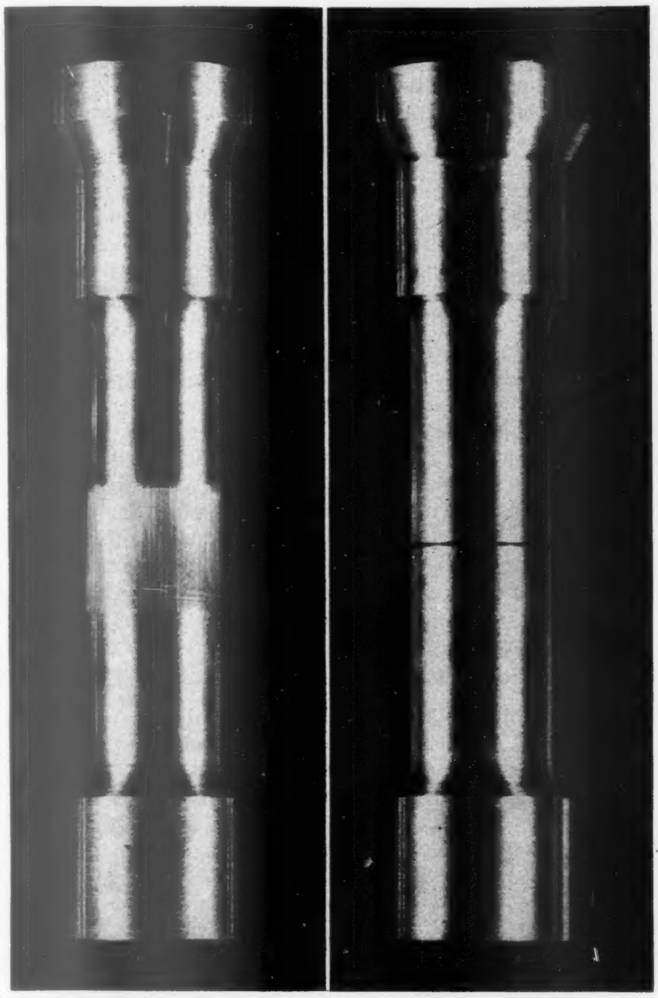


Fig. 5—Concentric-ground (left) and eccentric-grooved (right) tubular specimens of boiler flange steel used in the tension tests

strated by the cracking of a U-bend specimen without the use of a bolt to draw the ends together. In this case, however, the cracking appears on the inside of the bend because after bending and releasing the applied stress the elastic forces react to produce compression of the outer surface and tension on the inner. Fig. 4 shows such cracks as these on the inner surface of a specimen after it has been bent open slightly at the end of the test to make them more apparent. It is clear that residual stresses great enough to promote cracking of the grain boundaries may be left in the steel from cold work.

The failure of these U-bend specimens without applied load demonstrates the improbability that a riveted joint could be so fabricated that it would not fail in contact with a solution that causes intercrystalline attack. The joint could hardly be made without some cold working of the plate and rivet metal which would make it susceptible to cracking. Obviously, however, every precaution should be taken during boiler construction to cold work the steel as little as possible to keep to a minimum the area of metal in which cracking may start. The stress created by the steam pressure, while very important in designing the boiler, is probably of little significance in initiating intercrystalline cracking.

### Action of Solutions in Tension Tests

The U-bend tests that have been described were largely carried out in solutions boiling under atmospheric pressure. The equipment shown in Figs. 5 and 6 was used to test for intercrystalline cracking at the higher pressures normally encountered in boiler operation.

The specimen is tubular and closed at one end. The center section is ground, or eccentrically grooved as shown in Fig. 5. The specimen is inserted in the bomb as shown in Fig. 6 and the tensile stress is applied by means of the push rod passing up through the center. The solution to be used in the test is of course put into the bomb before the specimen is inserted. It is to be noted that this design makes it possible to apply a definite tensile stress to the specimen, while it is in contact with a heated solution under pressure, without the use of a packing gland or other device that might interfere with the actual stress reaching the specimen.

The first tests in this equipment indicated that sodium hydroxide alone had little influence on the load carrying ability of concentric ground specimens made of boiler flange steel at 482 deg. F. At this temperature the steel will break at a stress slightly above 80,000 lb. per sq. in. and Table II shows that the specimens would carry a load from 65,000 to 75,000 lb. per sq. in. even in contact with the concentrated sodium hydroxide.

**Table II—Resistance of Concentric Ground Tension Specimens to Failure in Sodium Hydroxide Solutions**

Test temperature 482 deg. F. (560 lb., gage)

| Applied stress, lb. per sq. in. | | Grams NaOH per 100 grams water | No failure, days |
|---|---|---|---|
| 75,000 | .......................... | water | 43 |
| 65,000 | .......................... | 10 | 19 |
| 75,000 | .......................... | 25 | 21 |
| 75,000 | .......................... | 25 | 43 |
| 70,000 | .......................... | 50 | 10 |

In the U-bend specimens it will be remembered that the action of the sodium hydroxide was greatly accelerated by the introduction of certain oxidizing agents into the solution. These compounds probably tended to form a partially protective layer over the crystal faces and to intensify the corrosion at the grain boundaries. These oxidizing agents might therefore be introduced into this tension test at 482 deg. F. to accelerate the intercrystalline attack of the hydroxide. As a matter of fact these compounds do not appear to serve the same purpose at elevated temperatures, probably because they are too reactive and are destroyed too quickly by contact with the steel surface.

**Table III—Failure of Concentric Ground Tension Specimens in Sodium Hydroxide-Sodium Silicate Solutions**

Test temperature 482 deg. F. (560 lb., gage)

| Applied stress, lb. per sq. in. | | Grams per 100 grams water | | | Failure, hours | No failure, days |
|---|---|---|---|---|---|---|
| | | NaOH | $Na_2SiO_3$ | NaCl | | |
| 70,000 | ............ | 25 | 0.4 | .. | 44 | .. |
| 70,000 | ............ | 25 | 1.7 | .. | 10 | .. |
| 60,000 | ............ | 25 | 3.0 | .. | 135 | .. |
| 60,000 | ............ | 25 | 3.0 | .. | 120 | .. |
| 50,000 | ............ | 25 | 0.32 | 0.3 | 32 | .. |
| 50,000 | ............ | 25 | 0.32 | 0.3 | 49 | .. |
| 45,000 | ............ | 25 | 0.32 | 0.3 | 79 | .. |
| 40,000 | ............ | 25 | 0.32 | 0.3 | 60 | .. |
| 35,000 | ............ | 25 | 0.32 | 0.3 | .. | 10 |

Other compounds appear, however, to produce this same type of partially protective layer at elevated temperatures, and sodium silicate is the one that most commonly appears in boiler operation. Table III shows the influence of sodium hydroxide-sodium silicate solutions on the load carrying ability of concentric ground specimens at 482 deg. F. Failure was produced in a few days at loads as low as 40,000 or 45,000 lb. per sq. in. From these results it is apparent that the sodium silicate

greatly accelerates the attack by the sodium hydroxide. Sodium chloride was added to solutions for the tests at low stress, for in low concentrations it also has been found to accelerate the cracking slightly.

The discovery that sodium silicate accelerated the attack of the sodium hydroxide solutions, especially at temperatures above 390 deg. F. (210 lb. gage) was of importance not only in understanding the cracks that occurred in boiler operation, but also in studying the action of various chemicals that might be used to prevent intercrystalline cracking. These chemicals could be introduced into the test equipment as shown in Fig. 6 with the sodium hydroxide-sodium silicate solution and if they prevented failure of the specimens they might be useful in boiler operation to eliminate cracking of the steel.

Tests have been run in this equipment similar to those shown in Table III at 302, 392, and 572 deg. F.; corresponding to 54, 210 and 1,280 lb., gage. This work has determined the influence on the failure time of practically all the inorganic ions present in the boiler water. It has also determined the lowest and highest concentration of sodium silicate and sodium hydroxide that had a measurable influence in producing cracks or failure. Many of the data have already been reported in the technical literature.* One point is, however, of particular interest; that is, the lowest concentration of sodium hydroxide which has ever been found to produce an appreciable reduction in load-carrying ability is approximately 7.5 grams per 100 grams of water.

* Schroeder, W. C., Berk, A. A. and Partridge, Everett P. Proc. Am. Soc. Testing Materials, 36, part II, pp. 721-54 (1936); Schroeder, W. C., Berk, A. A. and O'Brien, R. A. *Metals and Alloys*, vol. 8, No. 11, pp. 320-330 (Nov., 1937); Schroeder, W. C., Berk, A. A. and O'Brien, R. A. Trans. Am. Soc. Mech. Eng., vol. 60, No. 1, pp. 35-42 (1938).

### Concentration of the Boiler Water

The average boiler water does not contain more than 1,000 parts per million of sodium hydroxide. The concentrations of sodium hydroxide that have been shown to produce cracking in this report range from 7.5 to 50 grams per 100 grams of water; or from 75,000 to 500,000 parts per million. In spite of extensive effort no investigator has ever been able to show that dilute alkaline solutions, approximating the composition of actual boiler waters, would produce intercrystalline cracks. Therefore, intercrystalline cracks in boilers have been assumed to result from the action of the boiler water after it has concentrated several hundredfold. It can now be shown, under conditions of boiler temperature and pressure, that this assumption is true.

The only areas in a boiler in which the water could concentrate are those at least partially isolated from the main body of the water, such as may occur in riveted joints or rolled-in tube ends. Since intercrystalline cracking has never been definitely shown to occur in an operating boiler outside of these two areas they must combine the action of a number of factors that promote the intercrystalline attack on the steel, of which concentration is one.

**Table IV—Tests with Sodium Sulphate on Eccentric-Grooved Specimens**

Stress Applied at 482 deg. F. (560 lb., gage)

| Applied stress, lb. per sq. in. | Grams per 100 grams $H_2O$: NaOH | $Na_2SiO_3$ | $Na_2SO_4$ | Failure, hours |
|---|---|---|---|---|
| 40,000 | 25 | 0.16 | 16 | 120 |
| 40,000 | 25 | 0.16 | 16 | 36 |
| 40,000 | 25 | 0.32 | Saturated* | 5 |
| 40,000 | 25 | 0.18 | Covered† | 56 |
| 30,000 | 25 | 0.16 | Covered† | 80 |
| 40,000 | 25 | 0.35 | Covered† | 24 |

* Saturation is 29 grams $Na_2SO_4$ per 100 grams $H_2O$ at 482 deg. F. Rotated 24 hours to insure saturation.

† Specimen covered with loose crystals of sodium sulphate.

Two mechanisms might be suggested to explain the concentration of a boiler water in a riveted seam or tube seat. Fig. 7 shows diagrammatically a cross section of a riveted boiler seam. For the first concentration mechanism, it is assumed that the seam is tightly caulked on the outside butt strap. The inner butt strap has a very

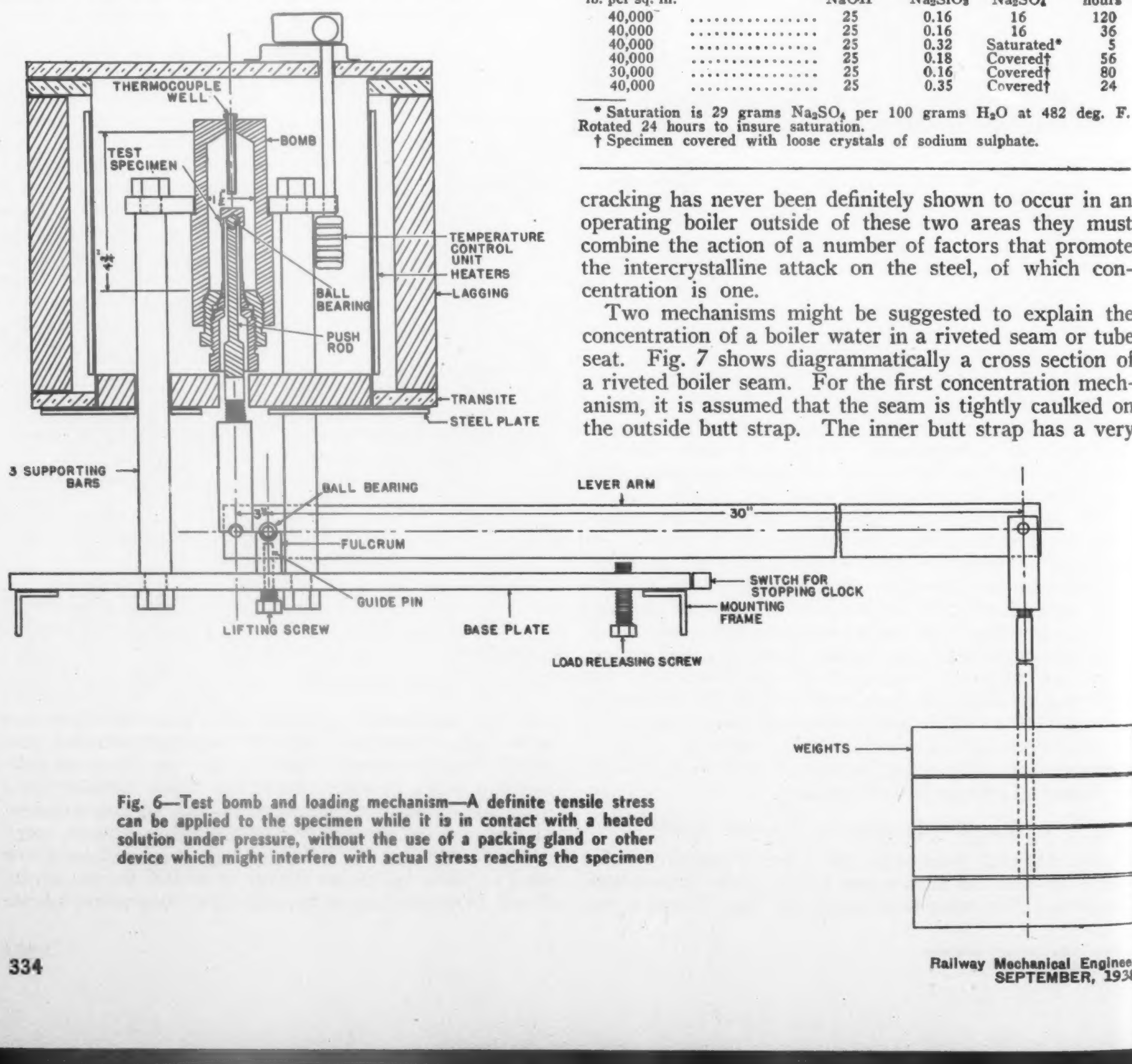



**Fig. 6—Test bomb and loading mechanism—A definite tensile stress can be applied to the specimen while it is in contact with a heated solution under pressure, without the use of a packing gland or other device which might interfere with actual stress reaching the specimen**

small capillary opening at *A*, and space *B* appears below *A*. The boiler pressure may fill *B* with solution and if the metal is hot enough the water will evaporate through *A* back into the boiler. When evaporation is completed the water from the boiler will tend to creep back through the capillary to condense a portion of the steam and let a few drops of solution enter *B* that will again evaporate. Eventually a concentrated solution or solid fills space *B*.

This process has been tested under atmospheric pressure in glass equipment with conditions essentially as pictured at *A* and *B* in Fig. 7. Concentrated solutions and even solid were produced in the capillary tube that corresponded to space *B*. Straub** ran somewhat similar experiments a number of years ago, forcing the water into *B* by increasing the pressure on the main body of water and then allowing evaporation to proceed by decreasing this pressure. This process also gave a concentrated solution.

This method could operate only if the riveted joint is receiving heat or if the pressure changes are extremely sharp. A concentrated sodium hydroxide solution boils at temperatures well above those required for dilute solutions. Therefore, to remove steam from such a solution in *B* against the boiler pressure would require that the metal be at a higher temperature than the boiler water. If the metal receives heat this is possible, but intercrystalline cracks have been found in riveted seams that do not receive heat and that would not presumably cause evaporation of the concentrated solution against the boiler pressure.

**Table V—Effect of Lignin-Containing Materials in Preventing Failure of Eccentric-Grooved Specimens**

Stress Applied at 482 deg. F. (560 lb., gage)

| Applied stress, lb. per sq. in. | | Grams per 100 grams $H_2O$ NaOH | $Na_2SiO_3$ | NaCl | Lignin* material | No failure, days |
|---|---|---|---|---|---|---|
| 40,000 | ............ | 25 | 0.16 | .. | 1.6 | 10 |
| 40,000 | ............ | 25 | 0.8 | .. | 1.6 | 12 |
| 50,000 | ............ | 25 | 0.8 | .. | 1.0 | 10 |
| 60,000 | ............ | 25 | 0.8 | .. | 2.0 | 10 |
| 50,000 | ............ | 25 | 0.8 | 0.5 | 2.0 | 10 |
| 50,000 | ............ | 25 | 3.2 | .. | 4 | 10 |
| 40,000 | ............ | 50 | 3.0 | .. | 1 | 10 |

* Dry powders produced from waste sulphate liquors.

Every boiler operator has seen concentration by the second method when he observes the deposits of solid on the outside of a seam, or rivet that is slowly leaking. Essentially the process demands the leakage or diffusion of solution past a restriction much more slowly than water evaporates toward the atmosphere. If this leakage and evaporation occurs at the exposed edge of the butt strap, it probably does little damage since the concentrated solution is in contact with drum metal that is not cold worked or under high stress.

If, however, the concentration should occur down in the seam or along a rivet a different situation exists. For example, in Fig. 7 the lower rivet may contact the metal only at point *D* on the one side. If boiler water leaks very slowly past *D*, the drop to atmospheric pressure at *C* will cause evaporation of the water to produce solid and a concentrated solution. Immediately, under the head of the rivet, a range of concentrations may exist as follows: (1) Dilute boiler water; (2) steam and more concentrated water; (3) steam, concentrated water, and solids; and (4) solids and a small amount of water.

If the rivet has been cold worked or is under high stress some solutions in this range may start cracking that will proceed until the head of the rivet comes off. This concentration mechanism could produce similar solutions in the seam and cause cracking in the butt strap, or in the drum metal.

The occurrence of intercrystalline cracks in an operating boiler indicates the simultaneous presence of at least four factors:

(1) A boiler water which when concentrated will produce intercrystalline cracking. The laboratory evidence now indicates that a water containing sodium hydroxide-sodium silicate will fall into this class if it does not contain an effective protective agent.

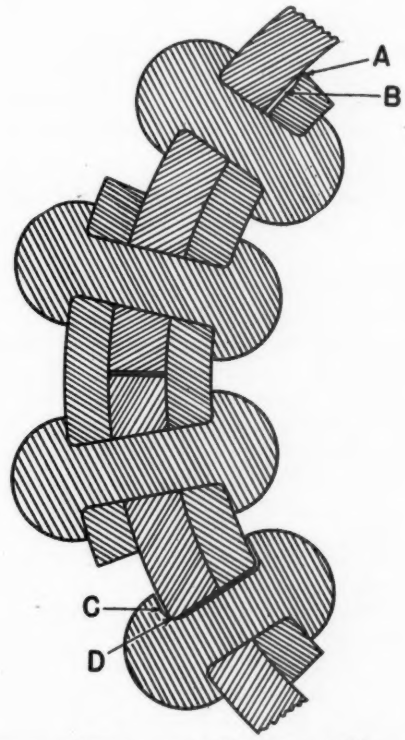



**Fig. 7—Diagram of boiler seam to illustrate possible methods of concentration**

(2) High stress in the metal. This may result either from residual stress from cold work or from external applied stress. In a riveted joint or rolled-in tube the effect of cold work would normally be more pronounced than the action of an applied stress.

(3) Very slow leakage in certain areas of the boiler that will allow the formation of a film of concentrated solution. Evaporation into the boiler, in case the metal is receiving heat, might also produce such a film.

(4) Contact of the film of concentrated solution with the highly stressed boiler metal.

### Protection Against Intercrystalline Cracking

On the basis of the four factors that cause intercrystalline cracking it is possible to list certain steps that may be taken to eliminate the difficulty.

First, an attempt may be made to treat the boiler water chemically so it will not cause cracking even though its concentrated solution is in contact with stressed steel. The major portion of the study of protection during this investigation has been devoted to finding and testing chemicals that might be satisfactory for this purpose.

Second, an attempt might be made to reduce cold work or other stresses in riveted steams and tube ends. Complete elimination of cold work is impossible, for rivets cannot be driven and tubes cannot be rolled to make them tight without some cold work. Excessive pressures, and excessive distortion of the metal should, however, be

** Straub, F. G., University of Illinois Engineering Experiment Station Bulletin No. 216, 1930.

avoided. Other means can also be used to reduce cold work. For example, boiler plate that is bent cold to form the drum should be annealed before the riveting is done. The careful annealing usually accorded welded drums is especially commendable in this respect.

Third, an attempt might be made to eliminate leakage and possible concentration of the boiler water. This would be difficult because the type of leaking that causes the greatest damage releases an almost undetectable amount of vapor or steam. Also even if the boiler were made thoroughly tight, thermal or mechanical changes might start slow leakage.

In stationary boilers leaks in seams have been eliminated by the use of welded instead of riveted construction. This is of course a very desirable procedure wherever it can be used, and leaves the tube seat the only point for the solution to concentrate.

### Chemical Treatment to Prevent Intercrystalline Cracking

The use of sodium sulphate is now recommended by the A. S. M. E. Boiler Code for the prevention of intercrystalline cracking. Practical evidence from many years of boiler operation has frequently been interpreted to indicate that this salt would stop the trouble.

In the tension testing bomb, as indicated in Fig. 6, sodium sulphate has not, however, given satisfactory results in preventing failure of the specimens. These tests have been run at 302, 392, 482 and 572 deg. F.; corresponding to pressures of 54, 210, 560 and 1,280 lbs. per sq. in., gage.

Table IV shows the results of a series of tests with sodium sulphate on eccentric grooved specimens at 482 deg. F. The stress was applied at operating temperature and failure occurred in every case. This is typical of the results secured at these temperatures. The sodium sulphate will offer more protection to the specimens when the stress is applied at room instead of elevated temperature, but even this effect is destroyed by higher concentrations of sodium hydroxide. A more detailed discussion of the tests with sodium sulphate will be found in an earlier paper.†

At 356 deg. F. (130 lb., gage) the action of sodium sulphate has also been tested in equipment for producing intercrystalline cracking in a stressed steel specimen that is in contact with a concentrated solution resulting from the slow leakage of a dilute boiler water past a restriction toward a region of lower pressure. Ratios of sodium sulphate to sodium hydroxide from 1 to 1, to 10 to 1 were tried and did not prevent the development of intercrystalline cracks and failure of the steel. It is believed the conditions existing in this equipment represent very closely those that cause cracking in the actual boiler. The laboratory results do not so far offer support for the belief that sodium sulphate will prevent intercrystalline cracking.

A large number and perhaps the majority of boilers in this country use feedwaters containing sodium hydroxide and sodium silicate and these waters are potentially capable of producing intercrystalline cracks. Some of them contain sodium sulphate and others are treated with it to maintain certain ratios of sulphate to alkalinity. In the majority of cases where this treatment has been used no cracking has occurred and it has been concluded that the sodium sulphate was responsible for the protective action.

This conclusion implies, however, that it is only necessary to have an embrittling water present in the boiler to cause cracking. This is not true, for at least three other factors must be present at the same time; high stresses in the steel, concentration of the boiler water, and contact of the stressed steel with this concentrated solution. If no control or information on these last three factors are available it is impossible to tell if the sodium sulphate prevented failure, or if failure would not occur regardless of the presence or absence of this salt. Briefly this means that lack of cracking in an operating boiler is not necessarily a criterion to indicate the non-embrittling action of the water. Reported cases of boilers operating for many years without cracking, using high alkalinities and little or no sulphate or other specific treatment to prevent intercrystalline cracking, furnish considerable support for this statement.

This reasoning does not necessarily imply that all boiler waters containing sodium hydroxide and sodium silicate will cause intercrystalline cracking even when their concentrated solution is in contact with the stressed steel. For example, the laboratory work has revealed certain organic chemicals that will inhibit the selective intercrystalline attack by the solution. Some of these compounds are present in certain feedwaters. Other unappreciated effects of certain chemicals may still be discovered although many of the compounds present in a normal boiler water have been very thoroughly investigated.

Certain organic materials have been found which were much more effective in preventing failure or cracking of the steel specimens than any inorganic chemical that has been tried. Lignin containing materials were very satisfactory, and are available at low cost in the waste sulphite liquors resulting from the manufacture of paper. For boiler use the waste liquors are generally evaporated to a dry powder or a solution containing 50 per cent dissolved solid. One railroad in the United States has used these concentrated solutions continuously for over ten years. The results indicate that this treatment was probably responsible for the elimination of cracking in a large number of locomotives each year. The treatment has not created difficulties in the way of scale formation, corrosion, or foaming, and in fact may have some desirable influence toward counteracting these troubles. The use of sulphite waste liquors is now being tried on several other railroads and in some stationary plants.

Table V shows the effectiveness of lignin materials produced from waste sulphite liquors in preventing failure of the eccentric grooved specimens at 482 deg. F. Specimens did not break with ten days in spite of high applied stress or high sodium hydroxide concentrations. If these results are compared with those in Table IV it can readily be seen that the lignin containing materials are much more effective than sodium sulphate in preventing failure.

Cutch and quebracho have also been found to be very effective in preventing intercrystalline cracking. Preliminary results indicate that the quebracho may be especially useful at low pressure. Both of these compounds are frequently used in feed-water treatment and their introduction into the boiler can be made with considerable background of experience. The protective action of these materials is receiving further study.

Several tests have shown that the ratio between waste sulphite liquor, cutch or quebracho and sodium hydroxide in the feedwater is not maintained in the boiler. These compounds may react with oxygen in the boiler and are adsorbed or carried down to some extent with any solid that may precipitate. Therefore, to make sure of the desired concentration it is necessary to analyze the boiler water. This is especially true during installation of the treatment to establish the correct ratio of treating chemical to sodium hydroxide in the feedwater. An analyti-

*(Continued on page 339)*

† Trans. A.S.M.E., vol. 60, January, 1938, pp. 35-42.

# Examples of Recent Locomotives of the 4-6-4 Type

## General Dimensions, Weights and Proportions

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Railroad | A. T. & S. F. | B. & O.* | B. & A. | Can. Nat. | Can. Pac. | Can. Pac. | C. & N. W. | C. B. & Q. | C. M. St. P. & P. | D. L. & W. | Me. C. | N. Y. C. | N. Y. C. | N. Y C. & St. L. | N. Y. N. H. & H. |
| Builder | Bald. | R. R. | Lima | Mont. | Mont. | Mont. | Am. | Bald. | Bald. | Am. | Bald. | Am. | Am. | Lima | Bald. |
| Road class | 3460 | Lord Balt. | J-2C | K-5a | H-1a | H-1c | E-4 | S-4 | F-6a | ...... | ...... | J-1c | J-3a | L-1f | I-5 |
| Road numbers | 3460-65 | 2 | 610-619 | 5700-04 | 2800-09 | 2820-49 | 4001-09 | 3000-11 | 6414-21 | 1151-55 | 701-02 | ...... | ...... | 174-177 | 1400-09 |
| Date built | 1937 | 1935 | 1930 | 1930 | 1929 | 1937 | 1938 | 1930 | 1931 | 1937 | 1930 | 1929 | 1937 | 1929 | 1937 |
| **Weights in Working Order** | | | | | | | | | | | | | | | |
| On drivers | 213,440 | 156,000 | 188,100 | 188,600 | 183,800 | 186,800 | 216,000 | 207,730 | 196.550 | 198,000 | 171,400 | 188,500 | 196,000 | 176,000 | 193,000 |
| On front truck | 83,950 | 45,000 | 67,100 | 66,000 | 63,100 | 61,500 | 87,000 | 69,320 | 76,970 | 82,000 | 55,520 | 61,500 | 66,000 | 53,500 | 71,500 |
| On trailing truck | 114,990 | 93,000 | 101,800 | 101,800 | 104,300 | 105,700 | 109,000 | 114,830 | 106,700 | 97,000 | 85,670 | 101,000 | 98,000 | 84,500 | 100,800 |
| Total engine | 412,380 | 294,000 | 357,000 | 356,400 | 351,200 | 354,000 | 412,000 | 391,880 | 380,220 | 377,000 | 312,590 | 351,000 | 360,000 | 314,000 | 365,300 |
| Tender, loaded | 396,340 | 199,800 | 209,800 | 305,800 | 291,900 | 288,650 | 360,000 | 326,020 | 287,780 | 313,100 | 189,610 | 279,000 | 314,300 | 206,200 | 332,000 |
| **Engine and Running Gear** | | | | | | | | | | | | | | | |
| Cylinders, diam. and stroke, in. | 23½x29½ | 19x28 | 25x28 | 23x28 | 22x30 | 22x30 | 25x29 | 25x28 | 26x28 | 26x30 | 23x28 | 25x28 | 22½x29 | 25x26 | 22x30 |
| Driving wheels, diam., in. | 84 | 84 | 75 | 80 | 75 | 75 | 84 | 78 | 79 | 80 | 73 | 79 | 79 | 73 | 80 |
| Driving wheel base, ft. and in. | 14–6 | 14–10 | 14–0 | 14–0 | 13–2 | 13–2 | 14–8 | 13–8 | 14–0 | 14–0 | 13–0 | 14–0 | 14–0 | 13–0 | 14–0 |
| Engine wheel base, ft. and in. | 14–1½ | 42–10½ | 40–4 | 40–2 | 39–6 | 39–6 | 42–4 | 39–11 | 40–9 | 40–7 | 35–8 | 40–4 | 40–4 | 37–9 | 40–1 |
| Engine and tender wheel base, ft. and in. | 88–8 | 81–6½ | 76–1½ | 79–4⅝ | 80–6¼ | 80–6¼ | 88–11¾ | 82–2¾ | 81–7½ | 81–2½ | 72–4¼ | 83–7½ | 83–7½ | 73–7¾ | 84–10 |
| **Boiler** | | | | | | | | | | | | | | | |
| Steam pressure, lb. per sq. in. | 300 | 350 | 240 | 275 | 275 | 275 | 300 | 250 | 225 | 245 | 240 | 225 | 275 | 215 | 285 |
| Diam. first ring, in. | 88 | 72 | 84¼ | 78 | 78½ | 78½ | 88 5/16 | 82 | 82 | 82 | 78½ | 82 7/16 | 80⅝ | 83 1/16 | 82 7/16 |
| Firebox length, in. | 132 | 114 | 130 | 126⅛ | 131 1/16 | 131 1/16 | 157 | 131⅞ | 120 | 130 1/16 | 120 1/16 | 130 | 130 11/16 | 114⅛ | 132 |
| Firebox width, in. | 108 | 78 | 90¼ | 84⅝ | 88⅞ | 88⅞ | 83 5/16 | 96 | 96 | 90¼ | 75¼ | 90¼ | 90¼ | 84¼ | 84⅛ |
| Tubes, number and diam., in. | 46–2¼ | 120–2¼ | 37–2¼ | 44–2¼ | 62–2¼ | 58–2¼ | 8–2 | 62–2¼ | 58–2¼ | 231–2 | 42–2¼ | 37–2¼ | 59–2¼ | 224–2¼ | 199–2¼ |
| Flues, number and diam., in. | 200–3½ | 27–5½ | 201–3½ | 146–3½ | 171–3½ | 171–3½ | 196–3½ | 184–3½ | 182–3½ | 52–5⅝ | 166–3½ | 201–3½ | 183–3½ | 45–5½ | 48–5½ |
| Length over tube sheets, ft. and in. | 21–0 | 25–0 | 20–6 | 19–1 | 18–3 | 18–3 | 19–0 | 19–0 | 19–0 | 17–6 | 20–0 | 20–6 | 19–0 | 20–0 | 18–0 |
| Fuel | Oil | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal | Soft coal |
| Grate area, sq. ft. | 98.5 | 61.75 | 81.5 | 73.7 | 80.8 | 80.8 | 90.7 | 87.9 | 80 | 81.5 | 62.6 | 81.5 | 82 | 66.7 | 77.1 |
| **Heating Surfaces, sq. ft.** | | | | | | | | | | | | | | | |
| Firebox and comb. chamber | 280 | 612 | 244 | 253 | 288 | 288 | 367 | 326 | 307 | 350 | 220 | 244 | 323 | 232 | 341 |
| Arch tubes and syphons | 95 | ...... | 37 | 92 | 38 | 38 | 140 | 43 | 100 | 127 | 86 | 108 | 37 | 70 | 139 |
| Firebox, total | 375 | 612 | 281 | 345 | 326 | 326 | 507 | 369 | 407 | 477 | 306 | 352 | 360 | 302 | 480 |
| Tubes and flues | 4,395 | 2,727 | 4,203 | 3,032 | 3,508 | 3,465 | 3,472 | 3,878 | 3,794 | 3,377 | 3,520 | 4,203 | 3,827 | 3,917 | 3,335 |
| Evaporative | 4,770 | 3,339 | 4,484 | 3,377 | 3,834 | 3,791 | 3,979 | 4,247 | 4,201 | 3,854 | 3,826 | 4,555 | 4,187 | 4,219 | 3,815 |
| Superheating | 2,080 | 880 | 1,920 | 1,492 | 1,640 | 1,640 | 1,884 | 1,830 | 1,815 | 1,123 | 1,760 | 1,951 | 1,745 | 1,045 | 1,042 |
| Comb. evap. and superh. | 6,850 | 4,219 | 6,404 | 4,869 | 5,474 | 5,431 | 5,863 | 6,077 | 6,016 | 4,977 | 5,586 | 6,506 | 5,932 | 5,264 | 4,857 |
| **Tender** | | | | | | | | | | | | | | | |
| Water capacity, U. S. gal. | 21,000 | 10,000 | 10,000 | 16,800 | 14,400 | 14,400 | 20,000 | 15,000 | 15,000 | 15,800 | 10,000 | 12,500 | 14,000 | 11,000 | 18,000 |
| Fuel capacity, tons or gal. | 7,000 | 16 | 17 | 20 | 20 | 21 | 25 | 24 | 20 | 26 | 14 | 24 | 30 | 16 | 16 |
| **General Data, estimated** | | | | | | | | | | | | | | | |
| Tractive force, engine, lb. | 49,300 | 34,000 | 44,800 | 43,300 | 45,300 | 45,300 | 55,000 | 47,700 | 45,880 | 52,800 | 41,300 | 42,300 | 43,440 | 40,680 | 44,000 |
| Tractive force, booster, lb. | ...... | 7,000 | 10,600 | 10,100 | ...... | ...... | ...... | 11,700 | ...... | ...... | 12,200 | 10,900 | 12,100 | ...... | ...... |
| Piston speed, 10 m.p.h., ft. | 196.7 | 186.7 | 209.1 | 196.1 | 224.1 | 224.1 | 193.3 | 201.0 | 198.6 | 210.1 | 214.8 | 198.6 | 205.6 | 199.5 | 210.1 |
| **Weight Proportions:** | | | | | | | | | | | | | | | |
| Wt. on drivers ÷ wt. engine, % | 51.8 | 53.1 | 52.7 | 528 | 52.3 | 52.8 | 52.4 | 53.0 | 517 | 52.5 | 54.9 | 53.7 | 54.45 | 51.1 | 52.8 |
| Wt. on drivers ÷ tractive force | 4.33 | 4.59 | 4.20 | 4.35 | 4.06 | 4.12 | 3.93 | 4.35 | 4.28 | 3.75 | 4.15 | 4.46 | 4.51 | 4.32 | 4.38 |
| Wt. of engine ÷ comb. h. s. | 60.2 | 69.7 | 55.7 | 73.2 | 64.1 | 65.2 | 70.3 | 64.5 | 63.2 | 75.7 | 5.60 | 53.9 | 60.69 | 59.7 | 75.2 |
| **Boiler Proportions:** | | | | | | | | | | | | | | | |
| Firebox h. s. percent comb. h. s. | 5.47 | 14.5 | 4.39 | 7.08 | 5.95 | 6.00 | 8.65 | 6.07 | 6.77 | 9.59 | 5.48 | 5.41 | 6.07 | 6.74 | 9.90 |
| Tube-flue h. s. percent comb. h. s. | 64.16 | 64.6 | 65.6 | 62.3 | 64.1 | 63.8 | 59.2 | 63.8 | 63.1 | 67.84 | 63.0 | 64.6 | 64.52 | 74.4 | 68.65 |
| Superh. surface percent comb. h. s. | 30.4 | 20.85 | 30.0 | 30.6 | 29.9 | 30.2 | 32.15 | 30.15 | 30.15 | 22.57 | 31.5 | 30.0 | 29.42 | 19.85 | 21.45 |
| Firebox h. s. ÷ grate area | 3.91 | 9.91 | 3.45 | 4.68 | 4.03 | 4.00 | 5.59 | 4.20 | 5.09 | 5.85 | 4.89 | 4.35 | 4.39 | 4.53 | 6.23 |
| Tube-flue h. s. ÷ grate area | 44.60 | 44.15 | 51.6 | 41.15 | 43.4 | 42.9 | 38.27 | 44.1 | 47.5 | 41.4 | 56.2 | 51.5 | 46.68 | 58.7 | 43.25 |
| Superh. surface ÷ grate area | 21.11 | 14.25 | 23.55 | 20.25 | 20.3 | 20.3 | 20.78 | 20.8 | 22.7 | 13.78 | 28.1 | 23.95 | 21.28 | 15.67 | 13.52 |
| Comb. h. s. ÷ grate area | 69.62 | 68.31 | 78.60 | 66.08 | 67.73 | 67.20 | 64.65 | 69.1 | 75.29 | 61.03 | 89.19 | 79.80 | 72.38 | 78.90 | 63.10 |
| Tractive force ÷ grate area | 500 | 551 | 550 | 587 | 561 | 561 | 606 | 543 | 561 | 648 | 659 | 519 | 529.8 | 610 | 571 |
| Tractive force ÷ comb. h. s. | 7.19 | 8.05 | 6.99 | 8.89 | 8.27 | 8.34 | 9.37 | 7.85 | 7.63 | 10.6 | 7.39 | 6.50 | 7.32 | 8.36 | 9.06 |
| Tractive force × diam. drivers ÷ comb. h. s. | 604 | 676 | 524 | 710 | 621 | 625 | 787 | 612 | 603 | 849 | 540 | 513 | 578.5 | 611 | 725 |

## Non-Skid Flooring And Stair Treads

A non-slip safety metal, which is highly resistant to rust and acid corrosion and unaffected in its non-slip properties by water, oil or other slippery liquid substances, is being manufactured by the American Brake Shoe and Foundry Company, New York. This product, marketed under the trade name of non-slip ABSCO metal, is formed by applying electric-furnace abrasive grains, the best anti-skid and hardest material known,

Non-slip ABSCO tread formed by applying abrasive grains to ferrous or non-ferrous products by a special method of casting

to cast iron, bronze, aluminum or nickel silver, by a special process of casting. The abrasive grains are deeply and uniformly bonded into the metal at the time of casting, thus forming a virtually indestructible bond between the abrasive grains and the metal. The grains protrude sufficiently above the surface to give a "bite" to the metal which, it is said, eliminates all possibility of slipping.

This casting process makes possible a wear- and corrosion-resistant "nose" to stair treads, since the abrasive grains are carried entirely over the "nose" and concentrated at this vital slipping point. Sluffing out and loss of abrasive grains, due to corrosion along the "nose," are prevented by this method, as no grinding is necessary to remove raw films of metal on the casting ridge.

ABSCO metal is designed for use as stair treads, ramps, industrial floors, platforms, elevator door sills, swing-type door thresholds, trench covers, etc.

## Lightweight Coach Seat

A new design of railway coach seat has recently been developed by the Transportation Seat Company, McCormick Building, Chicago, this seat being notable for its light but strong construction, unique rotating, reclining-back design and modern styling to provide a wide popular appeal. The cushion height and pitch, degree of recline of the original back position, height of the back and the arm rests, have all been worked out by architects and engineers familiar with these specialized problems to produce a seat design which will assure the greatest degree of riding comfort combined with attractive styling.

Individual coach seats of the new design weigh from 105 lb. to 115 lb., which is said to be roughly 25 per cent less than the present generally accepted standard for lightweight seat construction, or 50 per cent of the weight of the first revolving-reclining seats built for railway service in this country. The saving in weight is effected without the use of alloy metals and attendant increase in cost, ordinary carbon steel tubes and plates being combined in an efficient welded design.

The patented base allows seats of approximately 44 in. overall arm width to rotate independently on 39 in.

The seat with cushions removed to show rigid frame construction

to 40 in. centers with a clearance at the wall of ¼ in. to ⅜ in. without the necessity of pulling the seat away from the wall. The seat base is made of a combination of steel plates and tubing of welded construction, without moving parts. The entire mechanism requires a depth of only approximately ¾ in. A ball-type locking device eliminates the possibility of the seat turning due to any unusual motion of the train. The frame is of tubular steel construction, re-inforced with gussets and entirely welded throughout. The reclining mechanism for the independently reclined backs is of the unit type, lever operated, fully enclosed and applied directly to the seat frame. It may be removed as a unit.

The backs, mounted on roller bearings, are of steel tubing and plywood construction with either rubber or spring cushions. Seat cushions are of rubber or spring construction. The arms are wood, aluminum, or tubing. Arms, caps and cushions are removable.

Passenger coach seat with rotating and reclining back

## Analysis of Driving-Axle And Crank-Pin Failures

During the June 29 meeting of the General Committee of the Mechanical Division, Association of American Railroads, at which the reports of the year's work of a number of the standing and special committees were presented, a progress report on failures of driving axles and crank pins* was presented by W. I. Cantley, mechanical engineer of the Mechanical Division. It is the intention of the committee considering this subject to make further studies. For the present these studies will be confined to crank pins only, since the subject of driving axles is to be given consideration following the tests now being conducted at the Timken laboratory on passenger-car axles. It is the belief of the committee that if the members receiving copies of the report will analyze it carefully, they may find information in it which will be helpful to them in reducing failures on axles and crank pins similar to those now being experienced.

The following paragraphs are a summary of the major findings of the committee based on an analysis of the reports of the questionnaire sent by the Mechanical Division December 2, 1936, to 38 railroads in the United States and Canada and to which replies were received from 34 railroads. The report is confined to failures of axles and crank pins in actual service, but in the further study which the committee proposes to make they will also include crank pins which were found defective upon inspection.

### Driving Axle Failures

During the six-year period ended December 31, 1936, 895 driving-axle failures on 864 steam locomotives in freight and passenger service were reported by 34 railroads owning 70 per cent of the total number of locomotives in service in the United States and Canada.

The average rate of failures reported is approximately six driving axle failures per year per 1,000 locomotives in service.

There were approximately seven times as many failures of main driving axles as there were of other driving axles.

On freight locomotives, 80.7 per cent of all driving axle failures occurred in the journal. On passenger locomotives, 41.7 per cent of all driving axle failures occurred in the journal and 55.0 per cent occurred in or near the wheel seat.

No definite causes were given for 47.6 per cent of all driving axle failures. No definite cause was given for 68.8 per cent of failures in the wheel fit. The principal causes of driving axle failures in the order of frequency of occurrence are: Overheating in service, 67.6 per cent of known causes; poor material, 14.9 per cent; poor machining, 12.8 per cent; service conditions—wear primarily, 4.7 per cent.

A large number of failures at the wheel seat occurred on driving axles for which the reported actual diameter was smaller than the nominal journal diameter. There were fewer failures in or near the wheel seat of alloy steel driving axles than of carbon steel driving axles.

The fibre stresses of the majority of failed driving axles were below the A. A. R. recommended limit of 23,000 lb. per sq. in. The indications are that the limit of 23,000 lb. per sq. in. is too high, and that a reduction of this limit to 20,000 lb. per sq. in. would do much to reduce axle failures.

Check tests show a wide variation in physical properties of steel both for driving axles and crank pins manufactured to the same specifications.

### Crank Pin Failures

During the 6-year period ended December 31, 1936, 830 crank pin failures on 799 steam locomotives in freight and passenger service were reported by 33 railroads owning 68 per cent of the total number of locomotives in service in the United States and Canada.

The average rate of crank pin failures reported is approximately five failures per year per 1,000 locomotives in service.

There were approximately four times as many failures of main crank pins as there were of all others.

On freight locomotives, 84.8 per cent of all crank pin failures occurred at or near the outside face of the wheel. On passenger locomotives, 90.1 per cent of all crank pin failures occurred at or near the outside face of the wheel.

No definite causes were given for 64.4 per cent of all crank pin failures. No definite cause was given for 72.5 per cent of failures in the wheel fit. The principal causes of crank pin failures in order of importance are: Poor machining, 54.9 per cent of known causes; poor material, 21.0 per cent; service conditions—wear primarily, 19.0 per cent; overheating, 5.1 per cent.

The fibre stresses of the majority of the failed crank pins were above the A. A. R. recommended limit of 16,000 lb. per sq. in. The indications are that a reduction in the limit to 15,000 lb. per sq. in. would greatly improve conditions.

### Conclusions

The analysis of the returns clearly indicates that further study and research relating to driving axle and crank pin failures are required. Among important matters which should receive prompt and intensive consideration are:

(1) The incompleteness of many returns indicates the need for a more intensive and specific analysis of driving-axle and crank-pin failures as they occur.

(2) The cause of overheating of axles and crank pins and means of reducing the difficulty.

(3) The fatigue characteristics of those steels used in making crank pins and axles. This study should include the question of (a) whether fatigue strength requirements should be incorporated in material specifications and (b) what change should be made in the fibre stress limits.

(4) The design of and shop practices relating to axles and crank pins.

* This report is published by the Mechanical Division and is available for general distribution to members at 50 cents per copy and to non members at $1 per copy. It consists of 78 pages, 8 in. by 10½ in., and is bound in paper.

## Cracking of Boiler Steel

*(Continued from page 336)*

cal method has been worked out that may be used for any of these three chemicals. It is a colorimetric method, free from interference from the inorganic and from most of the organic constituents in the boiler water. Like most colorimetric methods it has the disadvantage of not being usable on highly colored waters. An attempt is being made to work out a precipitation method for such samples.

While these organic materials appear quite satisfactory for use in locomotive operation to prevent intercrystalline cracking, it is also desirable to have inorganic chemicals that would serve the same purpose. This would be especially true if the inorganic compounds were stable and of known controllable composition. Work in this direction should be and is now being done.

# EDITORIALS

## Are Wage Rates The Whole Issue?

Following negotiations between the Carriers' Joint Conference Committee, on the one hand, and the Railway Labor Executives' Association and the Brotherhood of Railway Trainmen, on the other, which began late in June, the proposal of the railroads of a 15 per cent reduction in wage rates is now in the hands of the National Mediation Board which has had the matter under consideration since August 11. Considering the course of the negotiations which led up to the 10 per cent wage reduction which became effective February 1, 1932, the attitude of the leaders of the labor organizations represented in the present negotiations is disturbing in the extreme to those who have hoped to see the railway industry restored to health. The hint of "after us the deluge" in the attitude of the spokesmen for this group offers little apparent basis on which to build a structure of mutual respect and confidence in the future. Hope lies in the possibility—even probability—that a substantial majority of the men who regard railroading as a career are not in agreement with this attitude of complete irresponsibility for the future welfare of the industry.

A. F. Whitney, president, Brotherhood of Railway Trainmen, at the outset of the present wage negotiations said that "Regardless of economic conditions, I desire to make plain to you gentlemen that any effort or attempt on your part to bring about a cut in wages and a lessening of the buying power of your employees is an attempt to defeat the efforts of President Roosevelt and of every person interested in economic recovery to save this nation, and it will be resisted by every power at our command." Later Mr. Whitney said: "To destroy the purchasing power of railroad workers by more than one quarter billion dollars a year will do nothing more nor less than prevent recovery. Reduced buying power means the bankruptcy of the railroads of this country. You cannot, and will not, solve your problems by continuing to pay interest to the bondholders by taking this money from the pockets of the railroad workers."

### Intelligent Selfishness

At the outset, let it be clearly understood that we are presenting no argument in favor of an attitude of unselfishness on the part of the railway employees whose wages the railways propose to cut. It is our hope that they may exercise such a degree of intelligence that they may *best* serve their selfish interests. To insist upon the immediate advantage of the reduced number of employees fortunate enough to remain on the payroll under present conditions is not serving the best interests of railway men at large or even of all of those at the present time actually employed.

A wage-rate increase is an added cost of production before it is added to purchasing power. Conversely, a wage-rate decrease effects a reduction in the cost of production to a greater extent than it reduces purchasing power, for the reason that a large part of the market for the products of industry and transportation lies outside the employed group of industrial and transportation workers.

Mr. Whitney's fear lest labor let something get away to the bondholders, at a time when approximately a third of the railway mileage in the United States is being operated by receivers or trustees and companies owning approximately half the mileage have been earning less than operating expenses for months, is a bit far fetched. It also ignores one of the basic conditions for any sound industrial and business recovery; that is, the restoration of the flow of capital into the transportation machine, as well as into other industry. Much railway traffic comes from the heavy goods industries which produce most of the goods purchased by capital expenditure, and an effort which, if successful, will prevent a re-establishment of this essential condition is not serving the interests of American workers at large or of railway employees themselves.

The immediate beneficiaries of a successful outcome of the course pursued by the railway labor organizations will be the relatively small group of trainmen and enginemen who have suffered little if at all during the present depression, thanks to mileage hogging. To the extent that traffic is offered, the employment of these men is safe. The number of employees in the mechanical department, however, can be reduced and, in fact, was reduced following the wage increase a year ago in order that the total outlay for maintenance might be kept within the funds available.

But why attempt to establish facts and build sound arguments upon them? The apparent muddiness of thinking on the part of many labor leaders during recent months suggests either a failure to understand that a system of private ownership cannot survive under conditions tending toward a permanent state of bank-

ruptcy, or a deliberate, but concealed, purpose of using the present crisis in the railway industry to effect the complete destruction of the present system of private ownership.

For some time there has been increasing evidence of an infiltration of economic and social ideas in the popular thinking which suggest the work of adherents of European left-wing philosophy. By and large, those holding such opinions realize neither their source nor their ultimate implications.

The communist's goal is a classless society in which there will be no display of selfishness because there will be no occasion for it. Each individual will be subject to the dictatorship of the whole of society. Paradoxically enough, this goal is to be attained by the "class struggle" in which the idea that the workers are at war with the rest of society is heavily stressed and in which appeal is to the selfishness and cupidity of the "masses" who, by and large, are the dupes of the left-wing leaders.

Since the class struggle is warfare, its conduct calls for complete suspension of the everyday rules of moral conduct. Lying and deception are "honorable" means of prosecuting the struggle in the minds of those who accept the doctrines of communism.

### Where Do Railway Men Stand?

This raises a serious question which should be faced by all those who believe in the basic soundness of the present economic and social system and particularly by those who wish to see the railway industry restored to health. One cannot say that a particular labor leader is a communist, unless he admits the fact, but the very character of communistic doctrines creates a presumption that those leaders who are participating in the prosecution of a communistic program are adherents of the cause themselves, even in the face of their denials.

American railroad men had better make up their minds where they stand on the issue of the preservation and improvement of what we now have, or its destruction and replacement by something unknown and uncertain which may evolve out of the chaos of destruction. If they decide against a philosophy and program formulated under conditions which never did and do not now exist in America, then let them deal appropriately with their subversive leaders.

## Who Are They—And Why?

A good bit of fun has been poked at the so-called "success stories" in some of the popular magazines. It cannot be gainsaid, however, that such stories are read avidly by many people. Moreover, if true, or reasonably well supported by facts, they can be a great inspiration to individuals who are ambitious and striving to make their personalities more effective in the attempt to get ahead. Unfortunately much good and inspiring material is buried and lost or forgotten, because no effort has been made to assemble it and make it generally available.

What a help it would be, for instance, if more facts and human interest material were available about those men who have made large contributions to the development of cars and locomotives and to the successful administration and operation of the mechanical department.

Those who served on the committee of the American Society of Mechanical Engineers which had charge of the program for the commemoration of the ninetieth birthday of George Westinghouse, were surprised and delighted at the large amount of really worth while and hitherto unrecorded material which was contributed by people who were associated with Westinghouse in the early days, or who were in a position to disclose authentic information about his character and activities. This in spite of the fact that an excellent and comprehensive biography had been written about Westinghouse by Colonel H. G. Prout.

To begin with, who are the men who should be listed for their achievements in the railway mechanical field? In the hurry and rush of this modern age some of these men have been overlooked or almost entirely forgotten. Yet the railroads of this country are only a little more than a hundred years old. Other men labored so quietly that they never did get the recognition their achievements deserved. Whom do you nominate?

Surely a list compiled with the assistance of the readers of the *Railway Mechanical Engineer,* a paper which dates back to the very beginning of the railroad era in this country, would be a matter of great interest and value today, as well as in the future. Will you help us compile such a list? What names can you suggest, and why? What supporting data or facts or incidents or references can your furnish that will help us to present these men to our readers. With your co-operation it should be possible to dig up and place on record material which, if not disclosed now, may in many instances be lost forever. What do you think of the idea?

## Motive Power Performance Not Properly Supervised

Remarkable improvements in locomotive design, efficiency and potential capacity have been effected in the past 20 years, for example, with steam pressures and superheat temperatures increased one-third, steam consumption per indicated horsepower decreased one-tenth, and potential horsepower output in some instances nearly doubled. Old locomotives have been retired and replaced by modern units as fast as practicable. The question is whether the railroads are securing maximum results from this large investment in modern power, combining as it does the latest refinements in

design with such important fuel-saving and capacity-increasing devices as up-to-date superheaters, feedwater heaters, Thermic syphons, stokers, boosters, etc.

While enviable locomotive performance records have been established in some instances, a new locomotive is no different from any other new appliance or shop tool in producing an output more or less proportional to what is demanded of it. In other words, unless the possibilities of the new tool are fully realized and adequate supervision provided to make sure that railroad men use the tool at somewhere near its maximum capacity, both while new and during its entire service life, its actual output may not greatly exceed that of the tool replaced. The answer to the question asked in the opening paragraph is that drastic reductions in supervision, including the retirement or demotion of many road foremen of engines, make it impossible for many railroads to get all the results they should with modern steam locomotives.

The following instance of locomotive misuse is believed to be typical and can probably be duplicated many times over on railroads throughout the country. Referring to the table, it will be observed that engine crews, using locomotives of identical design and hauling trains over the same division and under the same atmospheric conditions, moved heavy trains faster than light trains, owing to a psychological factor which, with proper supervision, could be capitalized and used to help the railroads reduce operating expense instead of increasing it.

**Selected Freight Runs in One Direction on a 125-Mile Division Showing Higher Speeds Maintained by the Same Class of Locomotive in Spite of Heavier Loads**

| Date | Number of cars | Gross ton loading | Time to top of last grade, minutes | Aver'ge speed, miles per hour |
|---|---|---|---|---|
| Dec. 15 ............... | 47 | 1612 | 64 | 25.8 |
| Dec. 13 ............... | 36 | 1628 | 62 | 26.6 |
| Dec. 14 ............... | 29 | 1669 | 65 | 25.4 |
| Dec. 17 ............... | 37 | 1840 | 61 | 27.1 |
| Dec. 18 ............... | 35 | 1942 | 60 | 27.5 |
| Apr. 14 ............... | 49 | 2045 | 60 | 27.5 |
| Apr. 20 ............... | 41 | 2105 | 60 | 27.5 |

The division in question is 125 miles long and the first 27.5 miles contain four ruling grades all of which are of the momentum type; that is, it makes a great deal of difference in maximum tonnage as well as speed of operation if the hill is approached at low or high speed. Engine crews on the runs referred to apparently had a schedule in their minds which they kept regardless of tonnage. Naturally, with the lighter tonnage they were not so keen about keeping up speed, as they realized that the grades would give them no serious difficulty. When the tonnage exceeded 1,800, however, there was some anxiety in their minds as to whether they would get over if they allowed the speed to drop. It was noticeable, therefore, that they made a serious effort to keep the speed up with heavier trains, thus resulting in a shorter time over this section of the road. The remaining 97 miles of the run were made without difficulty so far as grades were concerned, it being an easy task to maintain the maximum speed limit of 40 miles an hour. The figures quoted plainly show that, in the instance cited, the engine crews could and did get more out of their locomotives when they had to, but slackened their efforts when the going was easy.

The result of failure to get maximum output from modern steam locomotives is nowhere better exemplified than in the lowering of tonnage ratings when operating schedules are tightened and running time substantially reduced in response to the demands for ever-increasing train speeds. Some managements are entirely too willing to jump to the conclusion that drastic reductions in tonnage ratings must be made whenever schedule speeds are increased. Tonnage reductions of 50 per cent are sometimes made, as evidenced by one specific case in which the tonnage rating of a rebuilt locomotive was reduced from 4,000 to 2,000 tons to meet what was admittedly a rather difficult operating assignment. In another case it was considered necessary to reduce the tonnage rating of a certain class of locomotives from 2,700 to 1,500 in order to make the time on a new schedule. As a matter of fact, with the locomotive in good condition and the engine crew on its toes to secure maximum output, it was subsequently shown that this locomotive could handle 1,800 tons and meet the operating schedule without particular difficulty.

Locomotive efficiency and railroad efficiency are both very closely allied with the average percentage of maximum power output secured in normal locomotive operation. On the basis of fuel economy as well as minimizing the number of train miles required to handle a given traffic, it is essential to operate steam locomotives as nearly as possible at their maximum power rating. This means an adequate amount of intelligent supervision, with a full appreciation of the capacity of modern motive power and a positive check on and control of engine crews to make sure that these capacities are substantially realized.

## New Books

PROCEEDINGS ASSOCIATION OF AMERICAN RAILROADS, DIVISION V, MECHANICAL. *Published by the Association of American Railroads, 59 East Van Buren street, Chicago. Price, to members, $5; to other than members, $10.*

The proceedings of the session of the Association of American Railroads, Operations and Maintenance Department, Division V-Mechanical, held at the Municipal Auditorium, Atlantic City, N. J., June 16-23, 1937, contain also recommendations, letter ballots and other transactions for the year 1937. A list of the representatives at the meeting, the first full convention and exhibit since 1930, is also included.

# Gleanings *from the* Editor's Mail

**The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.**

## Older Men Help Apprentices

Conditions have changed considerably since I last wrote you. Now, we have only the older men around and they realize that they will soon be on the pension list. Therefore, they are more than willing to show us everything that they have learned in the way of car repairs, inspection, including all short cuts that save both time and money for the railroad. This makes our work more interesting and we are learning more than we ever learned before.

## Better Workmanship Required Today

At the present time, as never before in the history of railroading, managements are being forced to modernize motive power and rolling stock, and the back-shop equipment required to maintain and repair these new and expensive articles. New materials, new processes, closer tolerances, tighter fits, better finishes on machined work, more refinements on all equipment—all of these things complicate the modern railroad set-up, and call for a higher degree of skill in supervision and mechanics alike than ever has been known in railroading. Improved equipment soon loses its value if not cared for properly.

## Intense Use of Locomotives

I noticed a statement recently that some railroads are obtaining as much as 75,000 to 125,000 miles per year from their best freight locomotives. It is reported that a Milwaukee freight locomotive made as much as 19,200 miles in October, 1934. These, however, are extremes. The average performance of freight locomotives in actual service probably does not exceed 25,000 miles a year, if indeed it is that high. Traffic today is being handled by the cream of the motive power, for undoubtedly only the best locomotives are being utilized under present conditions. What would happen under peak traffic with all the motley array of obsolete locomotives in operation, is quite another question.

## Apprentices Attending Universities

I notice that arrangements can be made on the Canadian National to allow apprentices leave of absence to attend university during apprenticeship training. Three ex-apprentices are said to have completed a five-year university training in engineering and also their five-year apprenticeship. Of these, two graduated from the University of Manitoba with the degree of electrical engineer and one from McGill University with the degree of mechanical engineer. All three have been placed in the mechanical and electrical department of the railroad. At the present time four apprentices are attending university and still taking their apprenticeship training. It is found that those who take the combined apprenticeship and university training are better qualified to be advanced to supervisory positions and, no doubt, in time will make good executives.

## An Apprentice Philosopher

As to schooling along the lines of shop mathematics, blueprint reading, mechanical drawing, etc., we go to night school. Some of the fellows that have been furloughed think that the time they spent in school was wasted. This really shows that they have not spent enough time in school or they would realize that an education of any kind in any type of work will never be lost time. They might not need it for their present job (that is, those that are lucky enough to have jobs), but one never knows when he will need such an education. I noticed that several apprentices wrote to you saying that they had classwork on company time. I will admit that this feature would help to a certain extent, but after all, if a fellow is really interested in his job, he is willing to do a little more than he is asked to do, or a little more than he is paid for.

## Manufacturing Railway Equipment on a Production Basis

Probably one of the outstanding economic problems today is to bring down the cost of railroad equipment; namely, locomotives, passenger cars and freight cars. Practically every locomotive ordered for the various railroads is of a peculiar design; the same is applicable to both passenger train cars and freight train cars. Railroads and builders are equally responsible for this chaotic condition; however, I believe that the burden should be placed on the builders. If the builders would concentrate on one standard design; that is, a 1938 model 4-6-4 locomotive, a 1938 model passenger train coach, or a 1938 model box car, having the latest, most modern and up-to-date fixtures, at a real low cost, railroads could afford to pay the price and could be likened to an individual who would not pay the higher price for an automobile when a lower priced one would equally as well serve the purpose. It is believed that if such efforts were made by builders, savings in certain kinds of equipment up to 50 per cent could be attained, thereby having equipment at a price where railroads could afford to buy it, and create work for thousands of people.

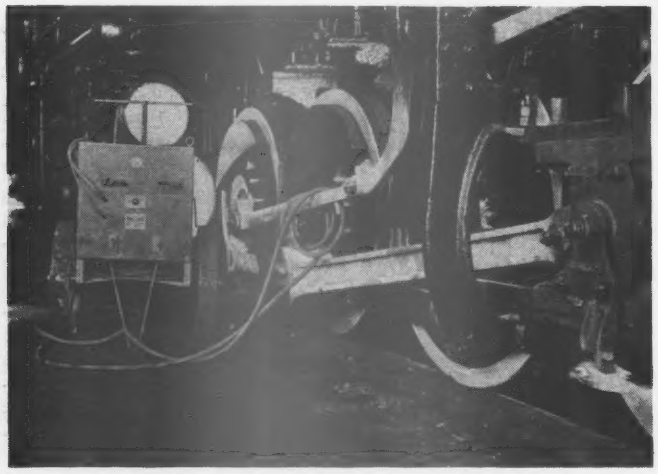
## The National Income

In your high spots, page 280 of the July issue, under the caption "We Wonder" you commented on the national income and its distribution. Owen D. Young, chairman of the board of the General Electric Company, in speaking on The Science of Better Living before the Industrial Personnel Institute at Purdue University last year, quoted from an article in the Yale Review by A. A. Berle, Jr., as follows: "The real object must be increase in the national income. . . . The job is to level up far more than to level down. Distribution is one problem, but if the ultimate goal is to be reached there must be a great deal more to distribute." Later in his address Mr. Young said, "I am sure that most people believe today that the preceding generation did a bad job economically. I do not share that view. If, as is estimated by the National Bureau of Economic Research, our national income was increased from $27,600,000,000 in 1909 to $86,000,000,000 in 1929—more than three times—if at the end of that period we had succeeded in distributing approximately five-sixths of that income to employees and independent operators like farmers and small business men, we ought not to be too severely critical of the economic management of the preceding generation. If the present, and those following, do as well both in production and distribution, there is real ground for hope that even the very high living standards to which we now aspire can be met."

## D. & R. G. W. Installs Magnaflux Inspection

*By Ray McBrian**

The Denver & Rio Grande Western has recently installed the non-destructive Magnaflux method of test and inspection for the prevention of failures by locating incipient flaws such as surface fatigue cracks. This method of flaw detection is by a process of magnetizing the ferrous part in such a way as to create a minute magnetic pole at the edge of any flaw, such as fatigue cracks and even flaws immediately below the surface of the material. On sprinkling the part being tested with the finely-divided perimagnetic material, polarization of the part causes this powder to outline the defect which, by other methods of inspection, would remain invisible. Tests made by the old inspection method, using whiting, have shown that this magnetic method discovers many more defects than could otherwise be found.

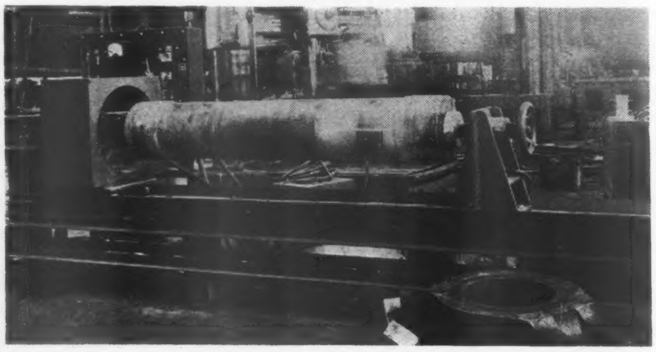


The portable outfit being used for the inspection of an eccentric rod while on the locomotive

The equipment installed on the railroad consists of a portable unit and a fixed unit at Salt Lake City, Utah, a portable unit at Grand Junction, Col., and a portable and a fixed unit at Denver, Col. These installations make for flexibility, and allow for inspection at the important main-line terminals thus insuring systematic, routine inspection of mechanical parts. The portable units can be moved to various terminals on the railroad whenever it is so desired.

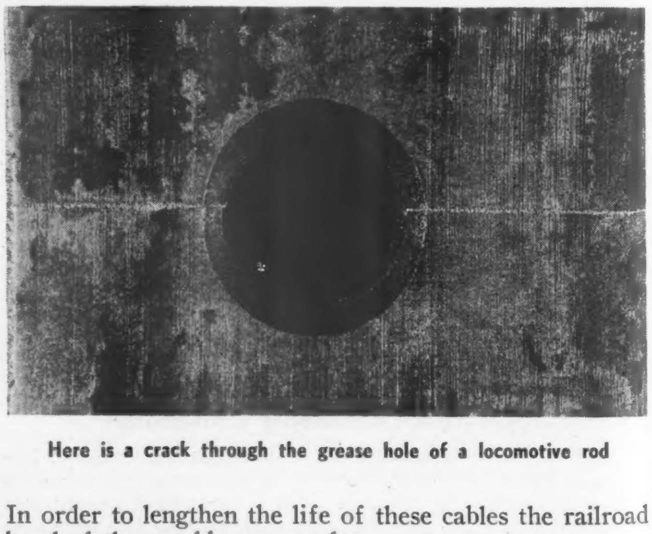
The portable unit is a compact power unit designed for the inspection of large or small parts and capable of being moved to any location where power is available. It is operated by alternating-current and capable of delivering a maximum of 3,000 amp. at 20 volts. In general, with the use of this unit, parts up to 10 in. or more in diameter may be examined for transverse cracks by wrapping four or five turns of cable around the part being tested and applying the maximum amount of voltage. The field is effective for only 18 to 24 in. on either side of the coil, and for long parts the coil must be shifted accordingly.

The stationary unit is built of heavy, structural-steel shapes entirely welded together and strong enough to support axle loads of 3,000 lb. The auxiliary equipment consists of two large structural-steel horses used to support from four to six side rods or other locomotive parts. The unit is alternating-current operated and capable of delivering a maximum of 5,000 amp. at 20 volts.



One of the fixed units testing axles in the shop

Cables used on both types of equipment for rod testing are No. 0000 extra-flexible stranded copper cables. In order to lengthen the life of these cables the railroad has had them rubber-covered.



Here is a crack through the grease hole of a locomotive rod

In order to permit the proper inspection of any parts under test, it is necessary to have the material cleaned of oil and grease and to have all the non-ferrous parts, such as brass bushings, collars, etc. removed. A perfectly bright, clean surface is not necessary as the powder will reveal the cracks through scale or rust.

The organization for handling the inspection consists of operators stationed at Salt Lake City, Grand Junction,

* Engineer of Tests.

and Denver. These men are electrical engineers capable of investigating and designing such new equipment as may be found advantageous, and work under the supervision of the engineer of tests.

Parts inspected, so far as locomotives are concerned, are handled in the back shop, the drop pit in the enginehouse, and the wheel shop. Also new castings are inspected upon arrival at the stores department or in the shops. The following are typical of the parts inspected: rods, eccentric cranks, crossheads, drawbars, hangers, levers, links, pins, plates, axles, springs, stems, wheels and yokes.

At the drop pit, the portable unit is used to test rods, valve-motion parts, crank pins, etc. which are removed from the locomotives. In the enginehouse, motion work such as rods and any other parts which it is desired to test are tested on the locomotives. In the back shop, practically all dismantled material from locomotives is tested using either the portable or the fixed unit. New forgings and castings are also tested.

Since Magnaflux inspection was installed, a total of 7,039 parts had been tested up to March 1, 1938, and of these, 1,533 had been found defective.

A report of the Magnaflux inspection is made daily on a form, showing the locomotive number, name of part

Laminations can be detected in boiler sheets through drilled holes and Magnaflux inspection

tested, nature and location of defect and the disposition of the part.

The testing unit is simply a device to lower the electric voltage and increase the current, and by means of a few turns of cable any desired amount of ampere turns can be secured. From observation on the railroad, from 500 to 2,000 amp. turns are generally found sufficient. In the set-up, the cable is wrapped directly around the parts to be tested and the part laid at right angles to the magnetic flow. This is a means of locating transverse cracks in locomotive side or main rods. In order to locate longitudinal defects, a heavy current of about 1,500 amp. is passed directly through the piece instantaneously, in which case the magnetization is circular. This method is especially advantageous for axles in routine testing, or for small tools where the defects or flaws are in the direction of the current flow. The magnetic powder can be applied wet or dry, as convenient, and either method is effective. On the D. & R. G. W. dry powder is used exclusively.

Compared with the old method of testing by whiting, this non-destructive method of testing has several positive advantages. In the first place, it is much more rapid as the magnetization is practically instantaneous and any number of pieces can be tested in a relatively short time. In the second place, an important advantage is that minute fatigue cracks and cracks which are in compression can be instantaneously discovered, but with the old whiting method, most defects of this kind were missed. Scale, which might be present, does not interfere with the inspection.

The accomplishments on the D. & R. G. W. by this method of inspection have been: (1) A substantial reduction in service failures by the detection of surface fatigue cracks in the material in service; (2) the prevention of failures by the detection of manufacturer's defects present in new forgings and castings; (3) the prevention of failures and saving of material by the location of small surface-fatigue cracks just originating or developing and grinding them out, thus preventing loss of material through failure; (4) the systematic checking of ferrous parts at terminals; (5) the study of the origin of fatigue defects and effecting a remedy by changing either design, manufacture, or service conditions, and (6) a close co-ordination of testing both service and material failures with the mechanical department which has resulted in substantial improvement in quality of material and in the reduction of road and service failures.

# Locomotive Boiler Questions and Answers

***By George M. Davies***

*(This department is for the help of those who desire assistance on locomotive boiler problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so. Our readers in the boiler shop are invited to submit their problems for solution.)*

## The Strength of Pitted Plates

Q.—Can you give an example of how a certified boiler inspector would set the factor of safety and the allowed safe working pressure on an old boiler that is over 30 years old, in which the comparison of the deterioration of the metal along the seams and the entire structure is involved?—C. M. C.

A.—The author is unable to give an illustration of a certified boiler-inspector's report, but the following information in regard to this question might be of some assistance:

The I. C. C. ruling regarding the factor of safety is as follows: "Rule 2. The lowest factor of safety for locomotive boilers, which were in service or under construction prior to January 1, 1912, shall be 3.25. Effective October 1, 1919, the lowest factor of safety shall be 3.5. Effective January 1, 1921, the lowest factor of safety shall be 3.75. Effective January 1, 1923, the lowest factor of safety shall be 4."

The following example is a good illustration of determining the effect of pitting in a sheet:

If the shell is extensively pitted—for instance, when measured longitudinally through the pitted areas and the pitted section is near or exceeds the measurement of

*(Continued on page 349)*

# BARE

"Six or seven hours!" The way Evans said it sounded like a convicted man repeating a life sentence he had just heard

"Did you bring that welding wire?" Henry Barton, boilermaker and welder in the Plainville roundhouse, asked the supply man.

"Sure, it's on the pilot of the 5088," the supply man replied. "When I go after something, I get it!"

Barton pried the lid from the box of $\frac{3}{16}$ welding wire. "Say!" he yelled at the supply man who was walking away. "I thought you said you got what you went after."

"Now, what's the matter?" the supply man paused. "You gave me a requisition for twenty-five pounds of $\frac{3}{16}$ welding wire. You got it, didn't you, or is there only twenty-four and three-quarter pounds?"

"I said coated wire!" Barton snapped.

"Aw, what's the difference?" the supply man asked. "The S. P. & W. pays you the same for using both kinds, don't they?"

"Aw, go to hell!" Barton picked up the box of welding wire and hoisted it on his shoulder. "I'll take it back to the storeroom and see if I can't get what I want."

# FACTS

### *by*

### Walt Wyre

• • •

"Say," Barton yelled, at the same time dropping the box of welding wire on the metal covered counter in the storeroom.

"Now what's eating you?" the storekeeper asked, walking towards the counter. "What's the idea of making so much noise?"

"I sent a requisition for coated welding wire and this is what you send me." The boilermaker pointed at the box on the counter.

"Haven't got any coated wire," the storekeeper said. "I ordered it, but that is what they sent. You'll have to use it."

"What's the matter, the S. P. & W. going broke?" Barton asked sarcastically.

"They would be if the store department bought everything the mechanical department wanted," the storekeeper replied. "Like this welding wire, for instance; the coated wire costs nearly twice as much as the bare wire."

"Yeah," Barton picked up the box of wire, "I'll bet if the store department had to use it they would be a durned sight more particular about the quality of the material they furnish."

When Barton got back to the roundhouse, Jim Evans, the foreman, was waiting at the door. "I'm in a hurry for the 5088," Evans said. "How are you coming on that crack in the fire-box?"

"I've got it all chipped out. That took a lot of time because it had been welded before and I had to chip out the old weld. If we could get the right kind of wire we wouldn't have so much trouble with welds in the fire-box giving way," Barton added.

"Well, get the 5088 finished soon as you can so we can get a fire in her. I'm expecting a call at any time on her."

The foreman went on through the roundhouse. Barton, still carrying the box of welding wire, went to the 5088 and climbed up in the cab.

The boilermaker's helper had strung out the welder cables and was waiting in the cab. "Going to need all of that wire on this job?" Barton's helper asked.

"Hell, no," the boilermaker replied. "But I don't care if you take what's left and dump it in the hot well after I get through."

When the foreman was about half through the roundhouse he met machinist Jenkins. "Say, Mr. Evans, how about getting the knuckle pin dowels welded on the 5076?"

"Both welders are tied up right now," the foreman replied. "Barton is on a hot shot job in the fire-box of the 5088 and Walters is building up driving boxes. We sure need another machine here. There sure is a lot of welding to be done."

The machinist stood hesitatingly for a moment, then Evans said, "Tell Barton I said to weld the dowels when he finishes the 5088."

THE foreman, eight hours late and two engines short, as usual, went on through the house and to the office hoping the dispatcher wouldn't call for an engine in the next couple of hours.

Evans sat down at his desk in the office and bit off a morsel of "horseshoe." His body was relaxed but his mind wasn't. He was thinking of work needed on the various locomotives assigned to the Plains Division.

The 5072 needed a new set of tires, the 5084 was overdue classified repairs, driving boxes were pounding, pins worn, and so on down the line. One needed this and the other needed that. Only a few were in good condition.

While he was thinking, the 5090 rolled in on the lead. She had just come in on a fast freight. "That's a good engine," Evans thought, and he mentally marked the 5090 for the Limited. The 5000-Class locomotives are used by the S. P. & W. for both fast freight and heavy passenger service.

Through the window the foreman watched the engineer walk around the engine feeling of bearings to see if any were hot. Something in the hoghead's actions didn't look just right to Evans. The foreman rose and walked out to the engine.

"Well, how did you make it?" Evans inquired.

"Like to not made it at all," the hoghead said peevishly.

"Run hot?"

"Naw, just the opposite," the engineer growled. "Couldn't keep steam, bad leak in the fire-box. If she was a coal burner, it would have put the fire out." The engineer shouldered his tin suitcase and started to the wash room.

Evans climbed up in the cab and opened the fire-box door. The fire-box was so full of steam he couldn't tell much about it. The leak appeared to be somewhere in the front end of the fire-box.

While he was in the cab the hostler came to take the engine around.

"Get her in the house soon as you can," the foreman told the hostler. "There's a bad leak in the fire-box. I want to get her blown down and repaired."

Barton finished welding the crack in the fire-box of the 5088, then welded the knuckle pin dowels for the machinist. When he had finished, he and his helper dragged the welder down to the other end of the house to the 5078.

Barton's helper was stringing out the cables and Barton was climbing up in the cab to go in the fire-box when the foreman came up.

"What have you got on her?" the foreman asked.

"Not much," Barton replied. "Some leaks in the flue sheets around the flues."

"Well, get them and as soon as the 5090 is blown down, see where all the leak in the fire-box is. I've got to use her tonight if there's any possible chance."

When Barton began examining the interior of the fire-box he found conditions worse than he had anticipated. All of the cracks were small, but there were many of them. A majority of the leaks were in old welds.

"We'll have to have a gun chisel," Barton told his helper. "You get an air hose connected up and I'll get the air hammer and chisel."

The boilermaker set to work chipping out the cracks so that the new weld would have good clean metal to adhere to.

Rat-tat-tat!—the noise in the fire-box was deafening, but the boilermaker, accustomed to it, didn't seem to mind. Metal chips flew as Barton veed out the cracks.

Evans passed by the locomotive and heard the air hammer going like a machine gun in the distance. Thirty minutes later the foreman passed again and the boiler-

maker was still chipping. Evans was beginning to be anxious and walked back to the cab to see how long it was going to take the boilermaker to finish.

"Hey!" Evans yelled in the fire-box door, then yelled again louder.

Barton, air gun in hand, turned towards the fire-box door.

"I thought there wasn't much to do in this one," Evans said. "From the way it sounds you've already cut out more than you'll get welded today."

"It's worse than I thought," Barton replied. "Nearly all of the cracks are old welds that have given away."

"Looks like we are having too much trouble with welds not holding," the foreman observed.

"That's right," Barton agreed, "and it's mostly because we're using the cheapest welding wire that the stores department can buy."

"I told the storekeeper to order coated wire," Evans said. "Didn't he get it?"

"Naw," the boilermaker laid the air hammer down and picked up several lengths of the welding wire he was using. He walked to the door. "Here's what we are getting and it's not worth a damn! It might have been O.K. ten or fifteen years ago," Barton said, "but they've got lots better than this now. The better grades of coated wire have nearly twice the strength and are lot faster to use."

The foreman took the lengths of welding wire. "How long is it going to take to finish this one?"

"Over an hour," Barton replied, "and then I'll just get the worst places. I'm just about through chipping," he added.

**E**VANS climbed down and went to the storeroom carrying the pieces of welding wire. "Say, why can't we get the kind of material we order?" the foreman asked the storekeeper.

"Don't know; what is it you didn't get?"

"Well, for one thing, why can't we get the right kind of welding wire? The welders claim that this bare wire is as out of date as wood burning locomotives and about as efficient."

"Aw, they just want something to bellyache about," the storekeeper said. "If it wasn't welding wire, it would be something else! Just like the machinists, they beefed about the steel we were getting for machine tools until we got the kind they wanted and now they want something different. This is the same kind of welding wire we've been getting for the past five years."

"That's the trouble," Evans observed. "By the time the stores department gets around to buying anything new, there's been an improvement made."

"O.K.," the storekeeper said as though he were just agreeing with the foreman to humor him, "I'll order coated wire again, but I doubt if we get it. It costs nearly twice as much and the purchasing department is trying to save the company money. They don't like to pay a fancy price for a lot of beet pulp stuck on welding wire just because it strikes the fancy of the mechanical department," the storekeeper added in what he intended to be a joking manner.

Barton finished in the fire-box, then leaving his helper to gather up the tools and wind up the welder cables, he went down to the 5090.

The leak was around the middle siphon collar and it was bad. It was another case of a weld having given away. Contraction and expansion from heat variation and strains from the weaving of the boiler had started a crack in the weakest place. The weakest place happened to be in the weld. Perhaps the welder in a rush to finish had grown a little careless and left a weak place in the weld. Perhaps even if the best grade of coated wire had been used instead of bare wire the weld would have failed, but not likely. The extra strength of the better wire would have lessened the chances for failure a lot.

Evans returned from the storeroom and went through the roundhouse to see how things were going. When he passed the drop-pit, machinist Jenkins stopped him.

"We're ready to cut the valve bushing out of the 5074," the machinist said.

Electric welders using a carbon arc are used at Plainville for cutting out valve bushings. Both welders were busy as section men when the superintendent's inspection car passed.

Evans scratched his head a moment, then said, "Just have to let the bushings go for the time being. Wish we had another welder," he added as he walked away.

The familiar rat-tat-tat in the fire-box of the 5090 told the foreman that Barton was beginning to work on her. He went over to see how much of a job it was going to be.

"What did you find?" Evans asked.

"Pretty bad," Barton replied. "It really should have a new plate welded in, but guess I can get by with chipping it out and welding."

"How long will it take?"

"I won't be able to get it finished before five o'clock," the boilermaker said.

"Can you finish by seven o'clock?"

"Yeah, I think so."

"Well, stay and finish it. I've got to have that locomotive."

More overtime to be explained, Evans thought as he walked to the office. Next to an engine failure, overtime was the hardest to explain satisfactorily.

Things went along fairly well for the next several days. Thinking of other things, Evans had almost forgotten about welding wire.

Barton had decided that trying to get the S. P. & W. to use coated wire was wasted effort, said no more about it, and did the best he could with the wire he had. He was, however, chronically behind with his welding as was the machinist welder.

**T**HEN the 5085 came in with a broken frame.

A sudden spurt of business as sometimes happens even now on the railroad left Evans hard pressed for locomotives. Every engine that was in condition to run at all, and some that weren't, was run.

The foreman was in the roundhouse marking up the board when the roundhouse clerk found him. "The dispatcher says he'll want an engine for an extra fruit train about six-thirty," the clerk told the foreman.

Evans looked at his watch. It was twenty minutes until two. Evans though a moment. "We haven't got anything but the 5085 that just came in. It got here, it should be able to go again."

"O.K., I'll tell him." The clerk went back to the office.

The inspector was at the same time looking over the 5085 out on the inspection pit. He had written down only a few items of minor consequence when he saw the broken frame. He stooped closer to look, but didn't need to get very close to see the break. He marked on each side of the break with a piece of light blue crayon and continued to look for further defects.

"Don't find too much on her; I'm going to have to run her east about six o'clock," Evans came up and said to the inspector.

"Well, I haven't found much but a broken frame."

Evans almost lost his temper when the inspector

grinned. Then he thought perhaps the inspector was joking. "Where's any broken frame?"

"Right here, and it's in a mean place to weld, too."

"Tell the hostler to get her in the house right away." The foreman turned and headed for the roundhouse almost at a run. He found Barton and told him about the broken frame. "How long do you think it will take to weld it with you and the machinist welder both working on it?"

"Depends on where the break is. I'd have to look at it first."

The hostler had the 5085 on the turntable preparing to put it in the house. Evans and the boilermaker went out to look at the broken frame.

"How long will it take?" the foreman asked anxiously.

"It's in a pretty bad place," Barton said. "Two welders couldn't work on it very well at the same time."

"How long will it take the best you can do?" Evans asked again. "I've got to have an engine and this is the only one left."

"Six or seven hours, I'd say if I have good luck. It'll take some time to vee it out and get ready to weld."

"Six or seven hours!" The way Evans said it sounded like a convicted man repeating a life sentence he had just heard.

"Well, I could do a lot better if I had some quarter-inch coated wire."

"How much better?"

"Oh, I could cut the actual welding time in half. It would take just as long to get it ready, though."

"Well, start getting it ready." Evans spun on his heel and headed for the storeroom like a boy with a nickel going after candy.

Barton's helper brought a cutting torch and rig down to the engine. The boilermaker lighted the torch and pulled a pair of goggles over his eyes.

"You might get the welder down here and string out the cables," Barton told the helper. "No rush, though. You'll have plenty of time while I vee out the crack."

"Did you get that welding wire?" Evans asked as he entered the storeroom.

"Sure thing," the storekeeper replied. "It's in the rack."

The foreman opened the gate and walked back to the rack where the welding wire was stored. He located a box of quarter-inch welding wire. Using a chisel, he opened the box.

"That what you are looking for?" the storekeeper inquired casually.

"Hell, no!" Evans snapped. "This is just like you've been getting all the time."

"It's what they sent," the storekeeper said, "and I guess you'll have to use it."

Evans picked up a length of the wire and looked at it a moment. "Say, do you suppose one of the welding shops up town would have some coated wire?" he asked suddenly.

"They might have," the storekeeper replied. "Why?"

"Thought I might trade them some of this. I'm going and see."

The foreman left the storeroom and returned a few minutes later in his car. He loaded two boxes of the quarter-inch bare wire.

"Come go with me," Evans said to the storekeeper.

On the way up town Evans explained the situation to the storekeeper.

"Yeah, we've got lots of coated wire," the owner of the contract welding shop said. "How much do you want?"

"I wanted to trade you some bare wire," Evans explained.

"I couldn't use bare wire at any price," the welder replied. "Even if you gave it to me, it would be too expensive on most jobs."

"Well, I guess that's that," the storekeeper said and started to the car.

"Like hell it is! We're going to buy some wire!"

"But I can't explain——" the storekeeper started to say when Evans interrupted.

"I'll do the explaining, all you have to do is pay for the wire. I believe I can explain it so that the next time the purchasing department buys welding wire they'll get the kind we want."

When Evans reached the roundhouse, Barton had the crack just about ready to start welding. Evans dumped the box of coated wire down beside the pit.

Barton shut off the torch and lifted his goggles. "That's more like it!" he said. "With two of us taking turns, we'll have this frame welded before you know it. But we won't get the overtime I was figuring on," he added.

## Locomotive Boiler Questions and Answers

*(Continued from page 345)*

the outer pitch of the longitudinal seam—determine the decrease in tensile strength of the plate that has deteriorated through the net section on a line between the two extreme pits, inclusive.

Assuming that all the pit holes in that line are deteriorated the worst, determine the result by the following calculations: First determine the factor of safety of the boiler by the formula:

$$FS = \frac{TS \times T \times e}{R \times P}$$

where $TS$ = tensile strength of the boiler shell plate, lb. per sq. in.; $T$ = thickness of shell plate, in.; $e$ = efficiency of the longitudinal seam, expressed as a decimal; $R$ = radius of largest shell course, in.; $FS$ = factor of safety; and $P$ = working steam pressure, lb. per sq. in. As an example, if $TS$ = 55,000 lb. per sq. in., $T$ = 0.75 in., $e$ = 0.86, $R$ = 42 in. and $P$ = 200 lb. per sq. in., then

$$FS = \frac{55{,}000 \times 0.75 \times 0.86}{42 \times 200} = 4.22.$$

Having determined the actual factor of safety of the boiler, determine the strengths by the following formula and example:

Let A-A = the section of the sheet between the extreme pits
TS = tensile strength of boiler plate, lb. per sq. in.
T = thickness of the plate, in.
B = approximate depth of pits, in.
C = distance between extreme pits or *A – A*, inclusive, in.
D = tensile strength of solid shell plate between *A – A*, inclusive, lb.
= T × C × TS
E = sum of diameters of all pits between A – A, inclusive, in.
F = tensile strength of shell plate that has deteriorated away through the net section between A – A, inclusive, lb.
= B × E × TS.
G = tensile strength of the remaining net section of the plate between A – A after deducting the tensile strength of the plate that has deteriorated between A – A, inclusive, lb.
= D – F.

Assume, for this problem, that $T$ = 0.75 in., as before, $C$ = 20 in., $TS$ = 55,000 lb. per sq. in., $B$ = 0.1875 in., and $E$ = 8.5 in. Then $D = T \times C \times TS$ = $0.75 \times 20 \times 55{,}000$ = 825,000 lb.; $F = B \times E \times$

$TS = 0.1875 \times 8.5 \times 55{,}000 = 87{,}656$ lb.; and $G = D - F = 825{,}000 - 87{,}656 = 737{,}344$ lb.

The tensile strength required by the factor of safety established by law can be calculated from the formula:

$$SR = (TS/FS)\ RFS \times T \times C$$

where $RFS$ = required factor of safety by law = 4; $SR$ = tensile strength required for $RFS$; $TS$ = tensile strength of the plate, lb. per sq. in.; $T$ = thickness of the plate, in. as before; and $C$ = the distance between the extreme pits, inclusive, as before. Continuing with the values previously given, the tensile strength required for the factor of safety established required by law, using the last given equation, is

$$(55{,}000/4.22) \times 4 \times 0.75 \times 20 = 781{,}984 \text{ lb.}$$

It is seen in the example taken, that $G$ is (781,980 — 737,344) 44,636 lb. less than $SR$; therefore, the tensile strength of the deteriorated plate falls short of that required, which shows that from a trifle more than 1$^{3}/_{16}$ sq. in. of deteriorated net section of plate in this example, about (44,636/55,000) $^{13}/_{16}$ sq. in. of the net section of shell plate between $A$ — $A$, inclusive, has deteriorated beyond the limit requiring a tensile strength equivalent to that for a factor of safety of four by law.

## Automatic Thread-Grinding Machine

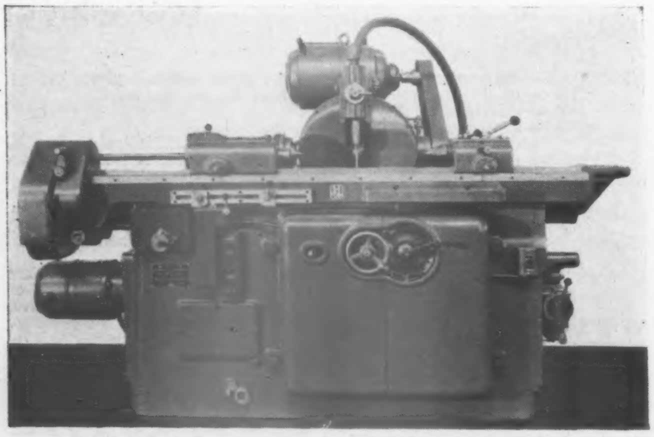
The Jones & Lamson Machine Company, Springfield, Vt., is manufacturing an automatic thread-grinding machine, which is designed to grind threads in hard or soft material on work up to 8 in. in diameter when using a 20-in. grinding wheel. Work 48-in. long may be held between centers, and 18 in. of thread may be ground anywhere on 36 in. of work length. Work 11½ in. in diameter may be swung over the work slide and 11½ in. diameter threads may be ground when the wheel is 16½ in. in diameter, or smaller. A 20-in. diameter grinding wheel is furnished as standard, and, as the wheel decreases in size, the proper peripheral speed may be retained through rheostat control of the wheel motor. The helix angle capacity of the new machine has been increased to include 25 deg. right hand and 30 deg. left hand. The helix angle is changed by a worm and gear.

Standard equipment includes change gears for pitches from 2 to 48, inclusive. The machine will grind single, double, triple, quadruple and sextuple threads, either right or left hand. Using a simple hardened and ground former, it will grind taper, combination of straight and taper, or double taper threads. Accurate reproduction of taper is assured. The grinding wheel is always at right angles to the axis of the work; therefore, no adjustment of thread form is required when changing from straight to taper threads, and the J. & L. method of grinding taper threads makes lead compensations unnecessary.

This machine, with the necessary attachments, will grind button-type hobs and circular chasers without lead; also, it will back off, or relieve, straight or taper hobs or taps with either straight or spiral flutes. A standard attachment may also be furnished for grinding interrupted threads on straight- or spiral-fluted taps.

A direct-current motor is recommended for driving the grinding wheel. One of the most important features is the provision made for running all types of grinding wheels at efficient work speeds. This is accomplished by a scale attached to the truing device for recording the wheel diameter at all times and a graduated rheostat with pointer indicating the spindle revolutions. A chart on the wheel slide shows the number of surface feet the wheel is running, based on the wheel diameter and spindle revolutions. As the wheel is reduced in diameter, the proper speed is maintained by simply turning the dial on the rheostat. While it is possible to furnish an alternating-current motor for driving the wheel, the company discourages the practice. Either alternating-current or direct-current motors can be furnished for the wheel-truing device, coolant pump and machine operations.

The self-truing, self-sizing mechanism of this machine brings thread grinding into the range of practical shop operations. It is suited equally well to tool-room and production work.

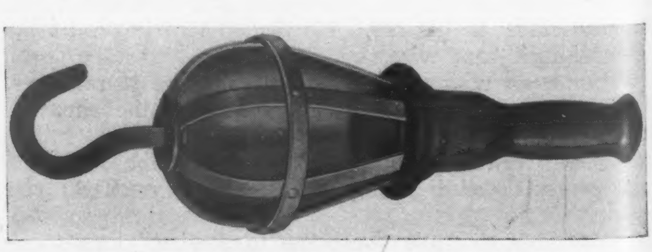


J. & L. automatic thread-grinding machine

## Screwless Shock-Proof Fiber Lamp Guard

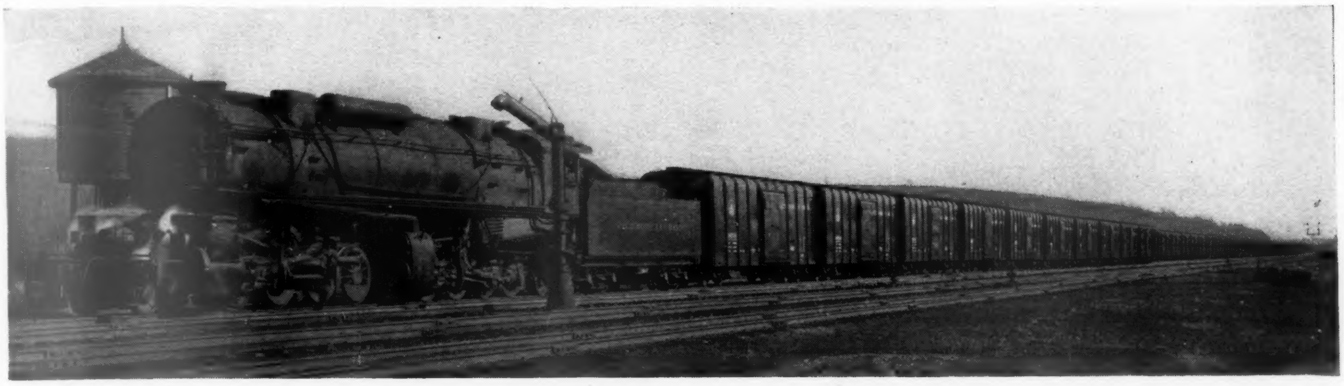
The illustration shows a screwless shock-proof lamp guard made of fiber with a heavy flexible rubber handle and rubber locking ring, the latter of which holds the fiber guard without the use of screws. The guard is made of flexible vulcanized fiber and is comprised of strips, a ring, a hook, and a reflector. The hook can be swiveled to hold the guard in any position. The rubber handle and rubber locking ring are made of 50 per cent pure vulcanized rubber and are designed to withstand a temperature of 350 deg. F.

The feature of this lamp is the means used for locking the fiber guard to the rubber handle. The solid rubber ring at the top of the handle is the only means used for holding the guard in place. When it is necessary to replace a globe this ring is rolled back along the handle and the fiber guard lifted out of place. The Safe Guard Electric Company, Inc., Brooklyn, New York, manufactures this device, which is known as the Wilson screwless shock-proof fiber guard.



The Wilson shock-proof fiber light guard

# With the Car Foremen and Inspectors



Train of 100 newly built wagon-top box cars leaving DuBois, Pa., en route to Pittsburgh

## B. & O. Builds 2,000 Wagon-Top Box Cars

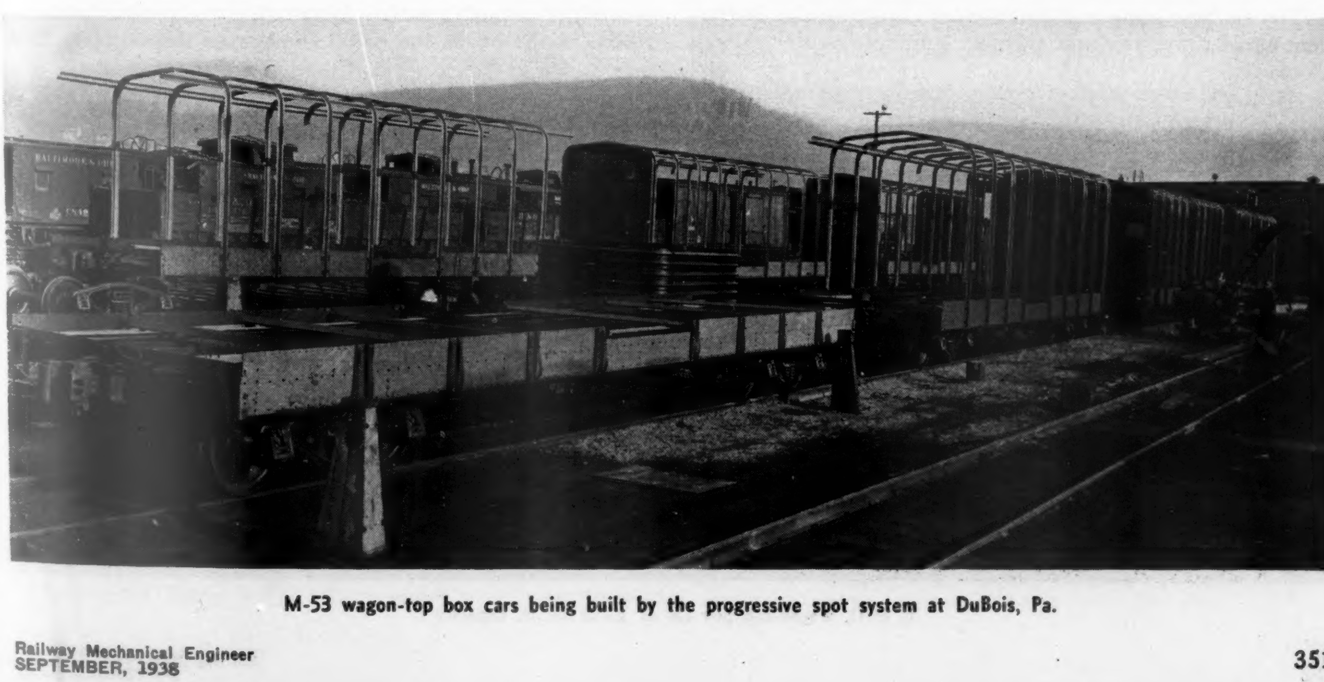
In June, 1937, the Baltimore & Ohio started the construction of 2,000 new wagon-top box cars, to be known as class M-53, all of which were completed by March, 1938. The design of these cars was first adopted in 1935 when the B. & O. built 13 experimental cars of various types, including five of the wagon-top design, using light-weight high-tensile alloys in their construction. Having demonstrated, through service test, the practicability of the wagon-top design, it was used in 1936 and 1937 when 1,300 box cars were scheduled for rebuilding. These were cars with wooden bodies on steel underframes of the fishbelly type, the underframes and trucks being still in serviceable condition, but on which the top had to be entirely replaced. New all-steel bodies of the improved wagon-top design were installed, thereby increasing the cubic capacity of these cars by 32.7 per cent over the original design with wooden body.

**Comparison of General Dimensions and Weights of B. & O. Class M-26e and Class M-53 Box Cars***

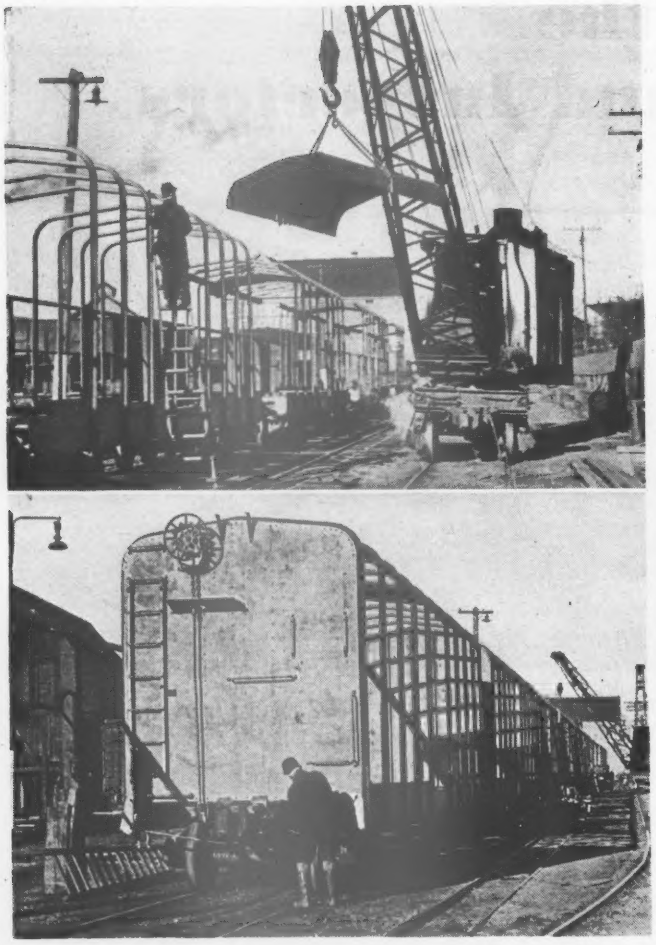
| | | |
|---|---|---|
| Class | M-26e | M-53 |
| Light weight of car, lb. | 48,100 | 46,500 |
| Load limit (revenue load), lb. | 120,900 | 122,500 |
| Ratio of payload to gross load | 0.715 | 0.725 |
| Capacity, cu. ft. | 3,056 | 3,712 |
| Inside length, ft. and in. | 40-6 | 40- 6 |
| Inside width, ft. and in. | 8-9⅛ | 9- 2 |
| Inside height, ft. and in. | 8-7⅜ | 10- 0 |
| Width at eaves, ft. and in. | .... | 9-10 |
| Height at eaves, ft. and in. | .... | 12- 7 |
| Length of car in train, ft. and in. | 45-4 | 45- 0½ |

* Both of these types have 5½-in. by 10-in. journals and Duryea underframes.

When the order for the new 2,000 car lot of wagon-top



M-53 wagon-top box cars being built by the progressive spot system at DuBois, Pa.

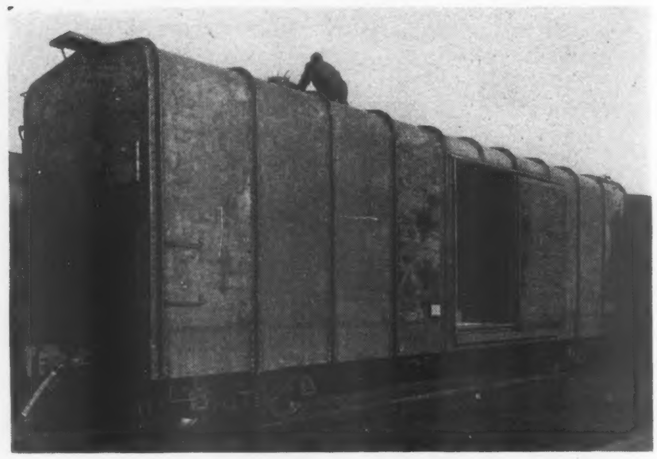


Top: Swinging the portion of the roof sheet over the doorway into place on M-53 box car—Bottom: The end of the car in place, but without side sheets applied

cars was placed, construction was distributed among various B. & O. shops as follows: 675 were built at Keyser, W. Va.; 575 at DuBois, Pa.; 385 at Chillicothe, Ohio; and 365 at Washington, Ind. All the cars were built by the progressive spot system, and it was found that the simplicity of their design and construction made it possible for a unit of 50 men to erect and complete two and one-half cars per working day of eight hours.

The underframes and trucks were built by the Bethlehem Steel Company and shipped complete to the various shops. The underframe is the Duryea cushion type, made of copper-bearing steel, in which the center sills are subjected to end loads or buffing shocks only, and are not a part of the car structure; they do not carry any weight of the body or super-imposed load. The B. & O. has found this type of underframe satisfactory in service and now has 14,000 cars in service equipped with them.

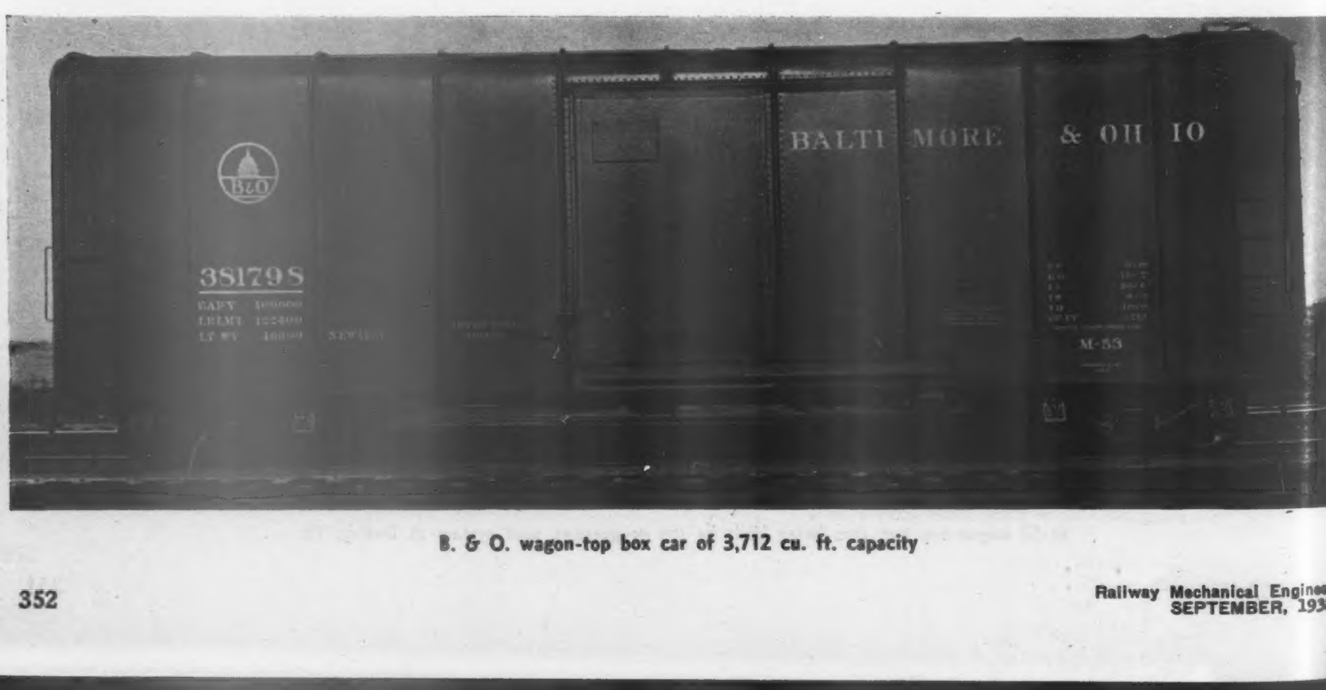
The trucks are made of grade B steel, with 5½-in. by 10-in. journals and integral-box side frames. The truck bolsters are equipped with roller-type side bearings.



Completed car ready for painting

No. 15 Buffalo and Damascus brake beams, and Schaefer truck connections are used. The trucks are also equipped with one-wear wrought-steel wheels and grooved journal bearings to trap waste grabs. Orders for the integral-box side frames and bolsters were distributed among the Buckeye Steel Castings Company, American Steel Foundries, Ohio Steel Foundry Company, Gould Coupler Company and the Pittsburgh Steel Foundry Corporation. All journal bearings were provided by the National Bearing Metals Corporation.

The body superstructure is the most interesting feature of this type of car, because of its radical departure from previous car designs. The superstructure is formed of combination side post and roof carline in one piece, extending up one side of the car, across the top, and down the opposite side. They are formed with a large radius at the eaves and drain slope from the center of the




B. & O. wagon-top box car of 3,712 cu. ft. capacity

roof. Riveted to them at the eaves, on the inside of the car, is a longitudinal side plate of the same shape as the side posts. These combination side posts and roof carlines were formed in their familiar U shape at the bolt and forge shop of the B. & O. at Cumberland, Md., on a machine especially designed for the purpose. Shipped to the various shops, ready to install, they were easily lifted into place by a crane and riveted to the side sills of the car.

The side sheets, made of copper-bearing steels, were fabricated at the Cumberland bolt-and-forge shop and shipped to the various shops ready for installation. These combination side-and-roof sheets, which are $\frac{3}{32}$ in. thick and which extend from the side sills to the center of the top, or ridge, of the car, are joined at that point by a waterproof riveted lap joint. Each sheet when applied is fastened first at the sides and then bent over to form the roof, making a continuous sheet from the side sill to the center of the roof. The sheets are riveted to the outside face of the flanges of the combination side posts and roof carlines, making it impossible for driving rains to hit the edges of the sheet and force its way into the car, the edges being protected by the channels of the frame members.

The ends of the cars were fabricated at Cumberland, each made from a single sheet of $\frac{3}{16}$-in. copper-bearing steel, stiffened by vertical posts. They are flanged and riveted to the end combination side post and carline flange.

The side doors, also fabricated at Cumberland, are made of a single sheet of steel, designed with two horizontal stiffeners on the inside. The bottom hangers are of the roller type mounted in steel castings and rolled on the flange of a 6-in. channel door track. Depressions formed in the door track assist in holding the door either in its open or closed position, and insure that the weight of the door is off the rollers when it is closed.

The interiors of these cars are lined with wood, except the ceiling. The floor is 1¾ in. thick and the side planking is $\frac{13}{16}$ in. thick. Nailing posts are imbedded in the hollows of the side-post channels, and their locations are marked with a black stripe on the face of the inside lining. Shippers are requested, by stencilled instructions in the car, to do their cleating and nailing at the places so designated.

These cars are equipped with Barber lateral-motion device, Type E automatic couplers which are operated by the Imperial rotary coupler release rigging, AB automatic air brakes, Ajax hand brakes, and improved side and end ladders which can readily be removed in transportation yards for repairs without requiring the car to be sent to the shop track.

The actual construction of the cars varied slightly at the various shops, depending on facilities available for handling the one-piece combination side posts and roof carlines, the side sheets, roof sheets over the doors, the ends and the doors. As shown in several of the illustrations a locomotive crane was used for this work, although at Keyser, W. Va., a gantry crane was employed. The trucks and underframes as received from the Bethlehem Steel Company were assembled at one end of the line, outside the shop and moved progressively for applying the side posts and carlines, ends, side sheets and doors. Interior work and finishing was done inside the shops, after which the cars were sent to the paint track for completing.

The table shows a comparison between a B. & O. box car of the conventional type, class M-26e, and the new car, class M-53. The points emphasized by the railroad in favor of the new design are lower maintenance cost, fewer parts, fewer joints where water may enter than in any other type of all-steel box car, and relative freedom from rolling insured by the lightness of the superstructure and low center of gravity. It is necessary to carry but few parts at repair shops to take care of the class M-53 cars, the only parts needed for the superstructure being the combination side and roof sheet and the combination side post and roof carline. The B. & O. is using cars of this type exclusively in trains Nos. 117 and 118, fast overnight merchandise freight trains operating between Pittsburgh and New York. Shippers are requesting them for loading and their popularity is said to be increasing daily.

# Loss and Damage And the Car Man*

***By Joe Marshall***

Whenever opportunity offers, I always suggest that the various car foremen's associations exchange information. The car men located in large terminals accumulate information of great value to the car men at the smaller loading points and terminals throughout the land. If a plan of this nature is not practical, there is another way to do it—tabulate information of value and pass it along with your suggestions to the freight claim conference in your district—they have almost direct contact with every loading point in the United States and Canada. Intermediate inspection points should take on the responsibility of catching loads originating at smaller points and promptly advising such points of all failures and how to avoid them.

You gentlemen know about the plan in effect for some years in Chicago Terminal district, under which all defects are tabulated and defective parts held for inspection and every possible effort made to repair cars in time for scheduled movement. I charted their 1937 report covering perishable traffic only. These figures show the changed conditions during the past ten years or so when light couplers, spring draft gears and related parts were responsible for the greater portion of our bad-order transfers. This chart shows the high spots to be wheels, 53.3 per cent; brake beams and attachments, 10.7 per cent; axles and cut journals, 9.4 per cent; journal boxes and column bolts, 6.9 per cent; truck springs, 5.2 per cent; inoperative air brakes, 3.8 per cent; spring planks, 3.6 per cent; and couplers and parts, 2.4 per cent.

**Observations on Special Equipment**

Auto device cars are an expensive addition to our special equipment and they become much more expensive when, through lack of ordinary care in replacing the racks after unloading, they fail under the next load and create damage to automobiles loaded therein.

One of the indoor sports of the trade has been that of panning the refrigerator car, based not on the millions of loads which carry safely, but upon a comparatively few failures due mostly to inexperience and abuse plus failure to capitalize the results seen at destination.

There is one serious defect worthy of study. This refers to hatch covers open for ventilation and jarred closed by vibration. A mechanical man ought to find no problem in devising a method for holding the hatch cover in open position during the movement of the car. You can think about the refrigerator car by noting the

* Excerpts from a paper presented by Joe Marshall, special representative, A. A. R. Freight Claim Division before the St. Louis Car Department Association at a meeting held at St. Louis, Mo., May 17, 1938.

causes for damage as recorded by your claim department and which you can help correct. There are 12 different items in the fresh fruit and vegetable group which cost from $10 to $21 per car in damage for every trip. One company equipped 20 cars with a longitudinal floor rack. For some reason they did not give the racks a test that would cover all classes of service. We think such a rack is necessary to prevent damage to case goods such as canned goods, sacked goods and basket goods. Some shippers are now demanding removal of crosswise racks when loading cars, which is a reminder that before 1918 the shipper supplied the false floor when he wanted it and the railroads made allowances when they failed to return the racks, and it was not long after federal control when all the carriers were equipping cars with permanent false floors. You, perhaps, have been called to pass on refrigerator cars, which it is claimed damage freight because of small openings around doors and plugs. Those in position to know, say this is the bunk. During May, 1936, the Freight Container Bureau, Association of American Railroads, ran a test car of celery from Florida to New York, to determine the effect of small cracks. There was little or no effect on temperature.

We still have too many different kinds of seal locks and hand brakes. Many of our appliances were developed by car and mechanical men. Perhaps they can help develop a uniform seal lock and hasp that will permit proper sealing and one that will not break under handling or show up without a pin as many do. Claim men first recommended standardizing of doors and fixtures back in 1922—we still want it.

We have been talking tank cars for years, all because of the difficulty of getting shipper loaders to follow the simple device of removing the outlet cap before starting the loading, which is the only sure way of knowing that the valve is properly seated and will not leak en route. We need the help of the car man here. One thought in connection with errors creating loss and damage is that we are beginning to hear about difficulty in reading or deciphering car numbers on freight cars. We have had experience with illegible car numbers on waybills. We hope we do not have the car itself added to that headache. Added to this, we have failures in removing old side cards. Every time a car is loaded, the old card should be taken off.

Last year the car service division complained about the use of high-grade cars for commodities which render them unfit for handling high-class traffic, which tends to keep open the age-old question of uniformity in commodity carding of freight cars. The claim man is interested in this question. We have had cases of very dangerous commodities contaminating a car. Car men might well advocate some penalty rule or some scheme whereby such cars will be carded home for proper cleaning or repairs. While it would involve changes in a great many rules, the remedy will probably not be approached until the rules prevent re-use of cars until cleaned and repaired, which action may force the next step—that of supervision against the inexcusable destruction of the useful value of 100 per cent equipment which is also destruction of railroad property.

One great difficulty is that of inducing users of freight cars to pull nails. Allowing for the natural disinclination of some folks to go out of their way to do something they do not have to do, perhaps we could induce some unloaders to help by presenting them with a simple tool that will do the job. A railroad shop can manufacture a gooseneck claw bar, approximately 30 in. long and ¾ in. thick at a cost of $1.06. With this tool a hardwood post should present no obstacle to the easy pulling of nails.

Years ago, we tried to induce grain unloaders to mark with chalk at points where cars leaked. We were never able to get this done as regular practice. At least one road has now established the practice of chalk-marking all defects to guide future repair work. It is a good practice from our standpoint.

Condensation is a current problem receiving expert attention. A great many different kinds of cars are under test. One road has two cars equipped with louvers which permit air circulation but prevent cinders entering car; there are other ventilator schemes indicating that much thinking is along that line. Some shippers are using anchor plates applied to freight-car walls for engaging the ends of steel strapping used as bracing for certain commodities. They are fastened with eight lag drive screws each 1¾ in. long and ⅛ in. in dia., with the result that car siding is destroyed in removing them. We have this up but you can help by inducing shippers to use nails instead of these heavy drive screws.

The Freight Container Bureau of the A. A. R. has designed a metal pocket which can be built into the car to serve as a permanent anchor plate. They call it the Conbur Brace. Those who are interested can secure a copy of descriptive circular from the bureau. When I talked to you on September 2, 1930, I gave a tabulation of tons per car and damage applying to lightweight commodities which account for the bulk of transit damage. I was talking of friction springs. A lot of water has passed over the dam since then, almost eight years ago. I won't go over that ground again. Many additional cars have been equipped with friction springs.

### Impact Speeds Must Be Limited

Hot boxes are ever with us and, regardless of alleged poor oil or poor oiling or other contributing causes for waste grabs and other reasons, we can say that excessive speed at time of impact contributes its share and that brings in the car man, because if cars receiving that kind of handling have to be re-worked by your inspectors before they take the road, to play safe, you have a good talking point. Just as some journal-box packers are extra good, so are some of our car handlers. The train man knows what happens when a journal runs hot, but he doesn't know what happens when cars are struck too hard—the car man can tell him. We are interested in the damage which results from over-speed impact—so are you.

I think it is understood that we can secure or obtain friction draft gears today with 2¾-in. travel, which will allow freight cars to be switched without closing the gear or causing damage up to speeds of five miles an hour, except the 90-ton and cars of greater capacity, but where is the yardman who is ready to determine on the spot that he has this kind of gear or that kind of car? When is he to know when he produces over 400,000 lb. of resistance and exceeds the safe load on the coupler shank? I am not a draft-gear man, neither are the yardmen, but you folks know enough about it to keep their thought in the safety zone by talking these things at meetings.

Two St. Louis roads stencil on the inside of their cars "Prevent Loss and Damage" or "Be Careful to Prevent Loss and Damage." We wish all roads would do this. In these days of stress, we need constant reminders. It only requires one or more earnest men interested in prevention in every yard to convert the unbeliever, help unload the alibi, and reduce the chances for rough handling. The lightweight freight car has been coming for a number of years. We certainly must meet it with lighter handling in train yards. We must go backward from heavier handling of heavier cars to lighter handling of lighter cars.

# Questions and Answers On the AB Brake

### Brake Cylinders (Continued)

323—*Q.—What observation should be made during the reduction?* A.—That an emergency application does not occur.

324—*Q.—What test should follow?* A.—The emergency test.

325—*Q.—How is this test conducted?* A.—With the device handle in lap position, open the ⅜-in. cock connected to the brake-pipe side of the test device.

326—*Q.—What is developed from this act?* A.—As the opening of the cock makes a reduction of the brake-pipe pressure suddenly, or at a fast rate, an emergency application must be obtained.

327—*Q.—How is it indicated?* A.—By the venting of the brake-pipe pressure to zero.

328—*Q.—In rare instances, what will cause failure to obtain the emergency?* A.—It may be caused by a decrease in the quick-action-chamber volume in the pipe bracket.

329—*Q.—How would this happen?* A.—It would be caused by an accumulation of moisture, which should be removed.

330—*Q.—What test should follow the emergency test?* A.—The release test after emergency.

331—*Q.—What should be done before attempting a release at the completion of the emergency test?* A.—Wait approximately 1 min.

332—*Q.—Why is this necessary?* A.—To permit the quick-action-chamber air to exhaust to the atmosphere.

333—*Q.—If this precaution is not taken, what would be the result?* A.—The quick-action-chamber air keeps the vent-valve piston to the right, holding the vent valve off of its seat, allowing brake-pipe air to escape to the atmosphere.

334—*Q.—How would you proceed to make the test?* A.—Move the test-device handle to No. 1 position until the brake pipe is charged to 20 lb., then move the handle to position No. 2.

335—*Q.—What must be observed after this?* A.—That the emergency piston moves to the accelerated-release position when the brake-pipe gage shows not less than 20 lb. or more than 28 lb.

336—*Q.—How is this piston movement indicated?* A.—By a rapid rise of brake-pipe pressure.

337—*Q.—What causes this rise?* A.—Air flowing into the brake pipe from the brake cylinder which is at this time connected to the auxiliary reservoir by way of the service valve.

338—*Q.—When is this flow of air into the brake pipe cut off?* A.—When the pressures are nearly equalized.

339—*Q.—What then controls the rate of the brake-pipe pressure build up?* A.—The test device.

340—*Q.—How long should this test be continued?* A.—Until the brake-cylinder piston returns to release position.

341—*Q.—What test should be made for brake-cylinder leakage only?* A.—Test should be made by using a test fitting inserted in the retaining valve pipe.

342—*Q.—How should this test be started?* A.—With 70 lb. pressure in the brake pipe, make a 20 lb. reduction by means of a single-car test device, returning the device handle to release position.

343—*Q.—Why is the test-device handle returned to release position?* A.—In order to have the service piston returned to release position.

344—*Q.—Does this movement discharge the brake-cylinder air to the atmosphere?* A.—Not in this case, as the test device in the retaining valve pipe retains the pressure.

345—*Q.—How much pressure would be retained?* A.—50 lb.

346—*Q.—What piston travel should be maintained for this test?* A.—7 in.

347—*Q.—Would it be satisfactory to obtain the brake-cylinder pressure by means of an emergency application?* A.—No. A service application should be made.

348—*Q.—In the event that a cylinder pressure higher than 50 lb. is obtained, should test be made anyhow?* A.—No. The pressure should be reduced to 50 lb. at the gage fitting.

349—*Q.—What is the maximum brake-cylinder leakage permitted?* A.—5 lb. per min.

350—*Q.—How would the test be made to cover combined brake-cylinder retaining valve and piping leakage?* A.—The cock in the test fitting is so turned as to connect the brake-cylinder pressure to the retaining valve via the retaining valve pipe. The retaining valve handle is placed in the high-pressure position.

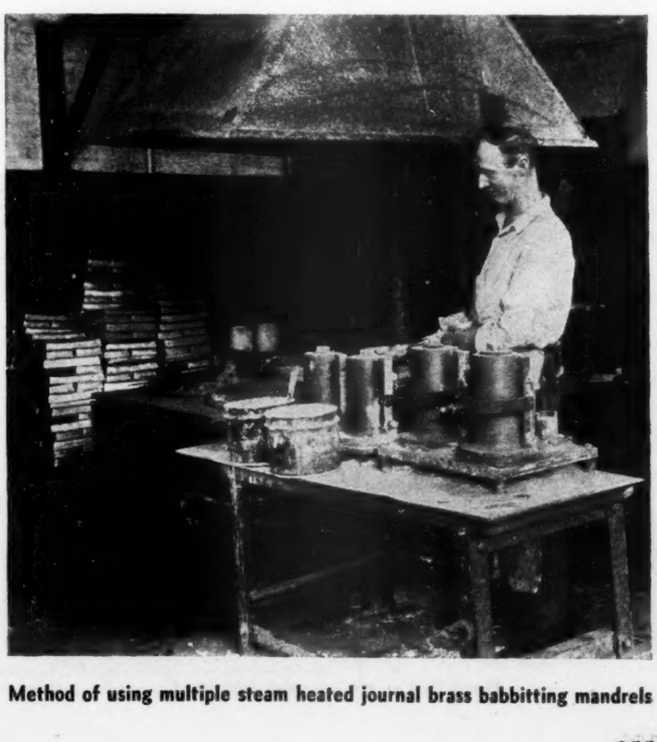
351—*Q.—At what pressure is the rate of leakage determined?* A.—15 lb.

352—*Q.—What should be the maximum allowable leakage per minute from 15 lb.?* A.—3 lb.

353—*Q.—If it were desired to obtain the blow-down rate of the retaining valve, how is this ascertained?* A.—With the retaining valve handle in high-pressure position, note the time required to reduce the combined pressure from 40 to 25 lb.

# Steam-Heated Babbitting Mandrels

To eliminate cold shuts in babbitting car-journal brasses, steam-heated mandrels are used at the Northern Pacific shops, Brainerd, Minn., being constructed as shown in the illustration. The mandrels are kept at an even temperature, cold shuts being eliminated and the time required for preheating of mandrels greatly reduced. Due



**Method of using multiple steam heated journal brass babbitting mandrels**

to longer time required for cooling of babbitt when using these mandrels, four mandrels are mounted on the bench to provide continuous work for the operator. Mandrels are mounted on a plate above the bench top to provide for circulation of air between the mandrels and bench top. Steam is piped under and up through the bench top to the mandrels.

## Heavy-Duty Fork Truck Is Motor Operated

The Elwell-Parker Electric Company, Cleveland, Ohio, is marketing a motor-operated fork truck with a rated capacity of 6,000 lb. and travel speeds up to 10 m. p. h. It is designed for the use of a ram, a fork or other accessory attachments that enable it to pick up any kind of load by direct contact, or on a pallet or a skid. Loads can be lifted from the floor, transported in a tilted position, and stacked without the operator leaving his position. The elevating equipment is operated by a cylinder which receives oil from a vane-type hydraulic pump, direct driven from the truck motor; however, lowering is accomplished by using a manually operated valve. The movement of the forks, either up or down, can be stopped instantaneously at any point of travel. Separate hydraulic rams tilt the upright standard to forward and back positions by means of levers.

The Elwell-Parker truck fitted with a ram for handling car wheels

Elwell-Parker gas-operated fork truck

The truck is powered with a four-cylinder gasoline engine which develops 33 hp. at a normal engine speed of 1,250 r. p. m. It has two-wheel drive, and is steered from the four wheels, steering being by hand through gear reduction. The truck has sufficient power to handle loads up steep ramps at high speeds; however, for safety, a transmission lock is used to hold the truck should it be necessary to stop it on a ramp. This same transmission lock permits acceleration when starting the truck after stopping on an incline.

## Decisions of Arbitration Cases

*(The Arbitration Committee of the A. A. R. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)*

### Repairs Claimed Excessive And Unwarranted

The Southern made repairs at its Columbia, S. C., shops to four Seaboard Air Line cars in September, 1936, and returned the cars empty to the owner within from one to five days after the repairs had been completed. The Southern later billed the S. A. L. to the amount of $546.09 for these repairs, but the S. A. L. contended that the charges should be canceled since (1) it connects with the Southern at Columbia, (2) it also has a shop at that point capable of making the repairs, and (3) failure of the Southern to send the cars to the home shops constituted a direct violation of A. A. R. Rule 1.

The Southern contended that a short time prior to its making the repairs the owner used the cars in revenue service on its own lines with the defects existing, and that the defects, which consisted of nailing sills and flooring badly decayed and part missing, constituted a hazard to train men and rendered the cars unfit for revenue service. At the time the repairs were made, the Southern pointed out that the cars were in great demand and it had no definite knowledge that the cars would not be loaded on its lines; also, since temporary repairs could not be made at a reasonable cost, complete repairs were made in accordance with the owner's standards.

A decision rendered by the Arbitration Committee on November 11, 1937, stated that: "The contention of the Southern that the cars were unsafe and unserviceable is untenable in that one car was received from the owner empty and subsequently loaded, two other cars loaded by the Southern while on its line and fourth car received under load and moved empty after unloading, indicated that the cars were safe and serviceable when received on line and until cars were received at the point where repairs were made.

Since the point where repairs were made is also a point of direct connection to the car owner, it is considered the repairs were made in violation of Rule 1 (b). The contention of the owner is sustained."—*Case No. 1760, Seaboard Air Line versus Southern.*

*(Turn to next left-hand page)*

*High Spots in*

# Railway Affairs . . .

### Few More Railroaders Working

According to the preliminary report of the Interstate Commerce Commission there were 929,477 employees on the railroads in July. This was an increase of 14,712, or 1.61 per cent over the previous month. Taking the 1923-25 average as 100, and allowing for seasonal variations, employment in July of this year stood at 50.7 per cent. Maintenance of equipment and stores forces were 29.28 per cent under July, 1937, although the reduction of the total forces for the same period was only 20.86 per cent.

### All About Motor Vehicle Drivers

The Interstate Commerce Commission is having its own troubles in solving the problem of how best to regulate common and contract motor vehicle carriers engaged in interstate commerce. Apparently it proposes to learn everything it possibly can about these services. For one thing, a study has been made by its Bureau of Motor Carriers of the drivers of the buses and motor trucks. As of July 1, 1937, data were submitted by 22,532 carriers for 128,038 drivers. Based on an analysis of about one-third of these returns, it was found that the average driver was 33.3 years old, 5 ft. 8¼ in. high, and weighed 165.4 lb.—a rather hefty bunch. The youngest drivers were 15 years old and the oldest 79 years. Of the 40,107 drivers considered in this study, 76 were below 18 and 300 were more than 60 years of age. Only 28 were women. On the average, the drivers had worked for their present employers 4.3 years; their average experience in driving trucks or buses, however, was 13.8 years, representing 250,000 miles of driving. While physical examinations were required of many of the drivers, no such examinations were reported to have been taken by 30.6 per cent of the bus drivers, 73 per cent of the truck drivers, and 40.9 per cent of the bus-truck drivers.

### Moving a Bumper Wheat Crop

Thus far this year the railroads have successfully handled the wheat crop. While it is much larger than that of last year, or any year since 1915, its movement is being spread over a longer period than usual. The railroads this year made still further improvements in planning to insure an adequate supply of grain carrying cars for the crop movement. Wet weather in wide areas also forced a return from the combine to the thresher-and-binder method of harvesting, thus considerably slowing up this work in these sections. In addition, the program for government loans on wheat and the low prices which have prevailed, have caused the farmer to hold back much grain from shipment. Because of this slowing up and spread of the movement, the railroads have been relieved of considerable extra expense in the transferring of men and locomotives, and other emergency measures. It is said, also, that there will be a heavy reduction in the claims for seepage and loss of grain because of the better cooperage of the cars and the fact that there is available an ample supply of properly constructed grain doors. It is estimated that the wheat crop in the United States will be 967,412,000 bushels, compared with 873,993,000 bushels last year, and an annual average of 752,891,000 bushels in the last 10 years.

### The Wage Controversy

The controversy over the proposal of the railways to reduce wages 15 per cent is now in its second stage. The negotiations between the carriers and their employees, which started on July 18, ended in a deadlock on August 3, and in accordance with the Railroad Labor Act, the services of the National Mediation Board were invoked. Because of its importance and the graveness of the situation, all three members of the board, Chairman William H. Leiserson, Otto S. Beyer and George A. Cook, are sitting in the hearings. These are being held behind closed doors and the board has indicated that silence on its part will be maintained until a agreement is reached, or until the efforts to mediate fail. The Brotherhood of Railroad Trainmen is still maintaining its aloofness from the rest of the labor group, and thus the Mediation Board is compelled to deal with three parties, holding separate meetings with the Carriers Joint Conference Committee, the Railroad Labor Executives Association, which represents 18 organizations of railway employees, and the Brotherhood of Railroad Trainmen. The meetings started in Chicago on August 11 and when this item was prepared there was no indication that an early agreement or disagreement would be reached.

### Rutland Workers Stay On the Job

Federal Judge H. B. Howe viewed the financial contingency on the Rutland so seriously that he indicated that the employees of that road could not remain as employees after August 4 unless they consented to a reduction of wages of from 10 to 30 per cent, according to the weekly bases. An agreement was finally made to withhold such amounts, but the deductions will not constitute a prior lien on the property against liens and obligations having priority in time, and will be made up only in the event of increased earnings by the carrier. The employees accepted these terms under protest. This action does not reduce expenses, but it does conserve the cash. The Rutland employees have now joined with the employees of the other railroads in fighting the proposed 15 per cent reduction in wages. The officers and members of the staff have already had their salaries drastically reduced. The shippers and business men along the road have formed the Rutland Railroad Co-operating Traffic Association, the purpose of which will be to assist the road in building up traffic and getting back on a sound financial basis. The city of Rutland has appropriated $1000 to the association and has voted to abate water assessments levied on the road for a period of one year, amounting to more than $2500.

### Rail-Auto Plan On the New Haven

Salesmen frequently drive their automobiles for long distances from their headquarters to the field, in order to have them available for making local calls or of using them more or less intensively in a comparatively limited territory. In such cases the railroads lose the long haul business, although the development of "Drive-Ur-Self" automobiles in many places has reacted to their benefit. Now comes the New Haven with the announcement that reduced mileage rates on Hertz "Drive-Ur-Self" automobiles may be obtained by its patrons in nine of the key cities which it serves. A standard receipt for failroad fare when a ticket is purchased will be evidence of transportation over the railroad. The cost of a reservation telegram up to 35 cents will be credited to the automobile rental charge. Passengers will also be transported free of charge between the railroad station and the Hertz garage.

(*Turn to next left-hand page*)


*All the locomotive fans are not in America—Correctly proportioned working models of modern and historic locomotives in the Railways Museum, Stockholm, Sweden*

# NEWS

## Four Historic Locomotives Now in Museum at Chicago

THE Chicago & North Western's "Pioneer" of 1848, the Illinois Central's "1401" of 1880, the Natchez & Hamburg's "Mississippi" of 1834, and the Baltimore & Ohio's "York" of 1831 have been installed in the Museum of Science and Industry at Chicago as a permanent exhibit. Replicas of these original locomotives have been made and will be used by the railroads for exhibition purposes.

## P. R. R. Shop Crafts Election

PLANS are under way for an election under National Mediation Board supervision to determine the union which will represent the 30,000 to 35,000 shop craft employees of the Pennsylvania, it has been revealed by Secretary Robert F. Cole of the Board. Contesting organizations in the election, the largest ever conducted by the Board, would be the American Federation of Labor's Railway Employees Department and the Brotherhood of Railroad Shop Crafts of America, Pennsylvania System. Two mediators of the National Mediation Board are now surveying the situation.

## Equipment Leases

*The Chicago Great Western* has entered into a contract with the Pullman-Standard Car Manufacturing Company for the leasing of 50 light-weight, all-welded, steel box cars of 50 tons' capacity, with an option to buy.

*The Chicago, Rock Island & Pacific* has entered into a contract with the Electro-Motive Corporation for the leasing of 16 Diesel-electric locomotives, with an option to buy, thereby bringing the total contracted for to 37, including 10 leased in April and 11 in March. Of the 37, 29 are 600 hp. and 8 are 900 hp.

## Equipment Depreciation Orders

EQUIPMENT depreciation rates for six railroads, including the Denver & Rio Grande Western, have been prescribed by the Interstate Commerce Commission in a new series of sub-orders and modifications of previous sub-orders in No. 15,100, Depreciation Charges of Steam Railroad Companies. The composite percentages, which are not prescribed rates, range from 3.61 for the D. & R. G. W. to 4.14 for the Sumter & Choctaw.

The D. & R. G. W.'s prescribed rates on standard-gage equipment are as follows: Steam locomotives (new), 3.13 per

(*Continued on next left-hand page*)

## New Equipment Orders and Inquiries Announced Since the Closing of the July Issue

| | | | |
|---|---|---|---|
| | LOCOMOTIVE ORDERS | | |
| Company | No. of Locos. | Type of Loco. | Builder |
| Boston & Maine | 3* | 600-hp. Diesel-elec. | Electro-Motive |
| | LOCOMOTIVE INQUIRIES | | |
| Ferrocarill de Antioquia | 2 | 2-8-2 | ..................... |
| Wheeling & Lake Erie | 5 | 2-8-4 | ..................... |
| | FREIGHT-CAR ORDERS | | |
| Road | No. of Cars | Type of Car | Builder |
| Southern | 23 | 40-ton box | Pullman-Standard |
| | 20 | 40-ton box | Mt. Vernon |
| | 95 | 50-ton gondola | American Car and Fdry. |
| | 3 | 40-ton stock | Ralston Steel |
| | 11 | 50-ton gondola | Pressed Steel |
| | 1 | 70-ton flat | Greenville Steel |
| Total | 153† | | |
| Manila | 50 | 30-ton box | Pressed Steel |
| | 50 | 30-ton flat | Gregg Company |
| | FREIGHT-CAR INQUIRIES | | |
| Illinois Central | ‡ | ............... | ..................... |
| | PASSENGER-CAR ORDERS | | |
| Road | No. of Cars | Type of Car | Builder |
| Newfoundland Railway | 1 | Dining | National Steel Car |
| | 2 | Sleeping | National Steel Car |
| | PASSENGER-CAR INQUIRIES | | |
| Southern | 6 | 2-car trains§ | ..................... |

* Delivery taken.
† In addition to the 5,550 cars reported in the June issue.
‡ Inquiry for prices of parts for 1,000 box cars.
§ Diesel-electric powered.

cent; steam locomotives ("second cycle equipment"), 4.1 per cent; freight-train cars (new), 3.17 per cent; freight-train cars (second cycle), 3.86 per cent; passenger-train cars (new), 4.03 per cent; passenger-train cars (second cycle), 3.75 per cent; work equipment (new), 3.14 per cent; work equipment (second cycle), 3.67 per cent; miscellaneous equipment (new), 14.52 per cent; miscellaneous equipment (second cycle), 18.69 per cent. On narrow gage equipment the respective percentages for new and second cycle equipment are as follows: Steam locomotives, 3.1 per cent and 3.55 per cent; freight-train cars, 3.11 per cent and 3 per cent; passenger-train cars (second cycle), 3.27 per cent; work equipment, 3.16 and 3 per cent.

# Supply Trade Notes

LUDWIG EMDE has been appointed Detroit district sales manager of the Worthington Pump and Machinery Corporation, Harrison, N. J.

FRANK D. NEWBURY, has been appointed manager of the New Products division of the Westinghouse Electric & Manufacturing Co., to succeed Herbert M. Wilcox, deceased.

NORMAN L. CAVEDO has been appointed southern representative of Crerar, Adams & Company of Chicago, with headquarters at 1717 Summit avenue, Richmond, Va. The Richmond office supersedes the sales division of the company's Washington, D. C., unit. Mr. Cavedo, who will sell railway supplies to all the southern railroads, also continues to represent the Federal Foundry Supply Company of Cleveland, Ohio.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO. has consolidated its transportation and generator divisions, and Frank Howell Stohr, manager of the generator division since last December, has been appointed manager of the combined transportation and generator division, with headquarters at East Pittsburgh, Pa. Frank B. Powers, formerly manager of transportation engineering, becomes engineering manager of the combined divisions.

V. B. EMRICK, representative of the Westinghouse Air Brake Company at St. Louis, Mo., since 1930, has been transferred in the same capacity to the southeastern district at Washington, D. C. Mr. Emrick, after serving with the Atchison, Topeka & Santa Fe, was employed by the Locomotive Stoker Company. He entered the employ of the Westinghouse Air Brake Company in 1929 as mechanical expert at the St. Paul, Minn., office and a year later was appointed representative at St. Louis.

### Obituary

HERBERT M. WILCOX, manager of the New Products division, of the Westinghouse Electric & Manufacturing Co., died suddenly from heart disease on July 28, in New York City. As manager of the newly created New Products division, Mr. Wilcox played an active part in introducing the Westinghouse precipitron, an electrostatic air cleaner.

COL. WILLIAM A. SMETHURST, of the sales department of the Baldwin Locomotive Works, at New York, died on August 12, at the Harkness Pavillion, Columbia-Presbyterian Medical Center, New York City, after five months' illness. Col. Smethurst was born 65 years ago in St. Augustine, Fla., and studied at Penn Charter School, Philadelphia, Pa. He entered the World war with the rank of major in the corps of engineers and was later promoted to lieutenant colonel. Since the war he had been in the service of the Baldwin Locomotive Works.

JOHN A. MACLEAN, president of the MacLean-Fogg Lock Nut Company, Chicago, died in that city on August 13. Mr. MacLean was born May 4, 1874, at Buffalo, N. Y., and entered the employ of the Corn Exchange Bank, Chicago, in 1892, with which organization he remained until 1902. From the latter year until 1905 he was in the employ of the Federal Trust and Savings Bank, Chicago, and from 1906 to 1909 was engaged in the insurance business. In 1910 he entered the employ of the American Locomotive Equipment Company, but a year later resigned to become associated with the Boss Nut Company, with which company he remained until 1925. In 1926 he was elected president of the MacLean-Fogg Lock Nut Company.

CHARLES HENRY TOMLINSON, formerly for 28 years sales engineer of the coupler division of the Ohio Brass Company, Mansfield, Ohio, died at his home in Mansfield, on August 10, following an illness of several months. Mr. Tomlinson was born at St. Louis, Mo., on July 6, 1869, and spent the early years of his business career in the West until 1906, when he left the Denver Tramways to go with the Ohio Brass Company as sales engineer of its coupler division, from which position he resigned in 1933 because of ill health. Mr. Tomlinson's work was identified with the development of automatic couplers for electric railways and more recently, tight-lock couplers for steam-railroad cars.

C. H. Tomlinson

# Personal Mention

### General

R. P. DOLLARD has been appointed shop engineer of the Chesapeake & Ohio.

A. STURROCK, master mechanic of the Esquimalt & Nanaimo, at Victoria, B. C., has been appointed assistant superintendent with the same headquarters.

GEORGE H. LICKERT, fuel engineer for the Union Pacific, has retired, after 37 years' service in capacities ranging from machinist to master mechanic.

E. C. MITCHELL has been appointed motive power inspector of the Huntington division of the Chesapeake & Ohio, with headquarters at Huntington, W. Va., succeeding S. E. Fulks, whose appointment as road foreman of engines, Handley coal sub-division was announced in the August issue of the *Railway Mechanical Engineer.*

NICHOLAS MCLEAN TRAPNELL, who has been appointed assistant to superintendent motive power of the Chesapeake & Ohio at Richmond, Va., as announced in the July issue of the *Railway Mechanical Engineer,* was born on December 30, 1900, at Elizabeth, N. J. He was graduated from Stevens Preparatory School, Hoboken, N. J., and studied mechanical engineering at Stevens Institute of Technology. Mr. Trapnell entered railroad service in July, 1919, as a machinist helper with the Coal & Coke Railway at Gassaway, W. Va. In February, 1921, he became junior marine engineer for the U. S. Shipping Board and later for the Barber Steamship Company. In April, 1922, he was appointed machinist, Meadows shops, New York division, Pennsylvania Railroad. In September, 1924, he became draftsman and later mechanical engineer for the Weston Electrical Instrument Company at Newark, N. J. In December, 1928, Mr. Trapnell

(*Continued on next left-hand page*)

# A·S·F ROLLER BEARING UNITS


**WHEELS AXLES BEARINGS**

**. . . handled as one assembly**

The handling of A. S. F. Roller Bearing Units follows standard railway practice.

Applied and removed like plain bearing wheel and axle assemblies.

Wheels turned without disturbing or protecting roller bearings.

Can be applied to existing equipment.

Wheels changed without removing roller bearings. Ordinary wheel presses used.

Being an integral assembly, the A. S. F. Roller Bearing Unit is easy and inexpensive to maintain.

**AMERICAN STEEL FOUNDRIES**

was appointed assistant engineer, operating department, Chesapeake & Ohio, at Richmond, becoming special engineer on the

N. M. Trapnell

staff of the vice-president and general manager in April, 1933. He was appointed mechanical engineer in August, 1936.

STEPHEN E. MUELLER, whose promotion to superintendent of motive power, second mechanical district, of the Chicago, Rock Island & Pacific, with headquarters at Kansas City, Mo., was announced in the August issue of the *Railway Mechanical Engineer*, was born at St. Louis, Mo., on

Stephen E. Mueller

January 31, 1885, and began railway service with the Rock Island on December 21, 1907, as enginehouse foreman at Rock Island, Ill. On June 1, 1910, he was promoted to general foreman at Fairbury, Neb., and later served as a general foreman at Rock Island and Cedar Rapids, Iowa. On October 1, 1919, Mr. Mueller became master mechanic at Estherville, Iowa, and on February 15, 1920, he was appointed assistant superintendent of shops at Silvis, Ill. Mr. Mueller became superintendent of shops at Silvis, Ill., on July 1, 1922.

ALVIN R. RUITER, whose promotion to assistant chief operating officer, mechanical, of the Chicago, Rock Island & Pacific was announced in the August issue of the *Railway Mechanical Engineer*, was born at Dumont, Iowa, on January 26, 1880. He entered railway service on the Rock Island as a machinist at Valley Junction, Iowa, on November 19, 1906 and later served as machinist foreman and enginehouse foreman. On January 1, 1913, he became general foreman at Valley Junction, and on June 1, 1915, was transferred to Silvis, Ill. He was later appointed master mechanic at Armourdale, Kan. Mr. Ruiter served also as master mechanic at Armour-

Alvin R. Ruiter

dale, Chickasha, Okla., and Shawnee, Okla., and was master mechanic at Armourdale at the time of his appointment as assistant chief operating officer mechanical.

### Master Mechanics and Road Foremen

MURRAY KENNETH ROBB, who has been appointed master mechanic of the Canadian National at Prince Albert, Sask., as noted in the August issue, was born on July 16, 1891, at Smith's Falls, Ont. He attended Public School Collegiate at Ottawa, Ont., entering the service of the Grand Trunk Pacific (now the Canadian National) as a messenger in the freight department. He subsequently became a machinist apprentice; machinist at Fort William, Ont.; machinist at Transcona, Man. (in 1915), and machinist at Sioux Lookout, Ont. (in 1917). In March, 1918, he was transferred to Regina, Sask., as shop foreman. He was appointed locomotive foreman at Regina in October, 1918; at Nutana, Sask., in 1929; at Regina in 1931, and at Nutana in 1932. He became master mechanic at Prince Albert on June 15, 1938.

C. D. SMITH, who has been appointed master mechanic of the Portage Brandon Division of the Canadian National at Winnipeg, Man., as noted in the August issue, was born on February 23, 1888, at Creemore, Ont. He received a high-school education, and in June, 1903, became a machinist apprentice on the Canada Atlantic. He became a locomotive fireman on the Canadian Pacific in 1906. Mr. Smith entered the employ of the Grand Trunk Pacific (now the Canadian National) in 1907, and until June 16, 1938, served successively on the Canadian National as locomotive fireman, locomotive engineer, road foreman of engines, acting general road foreman of engines, and master mechanic at Sioux Lookout, Ont.

### Shop and Enginehouse

E. A. BENDER, assistant enginehouse foreman of the Norfolk & Western at Bluefield, W. Va., has been promoted to the position of day enginehouse foreman.

B. W. HENLEY, day enginehouse foreman of the Norfolk & Western at Bluefield, W. Va., has been promoted to the position of general foreman, succeeding F. R. Forrest, deceased.

F. A. SARVER, gang leader at the Bluefield, W. Va., shop of the Norfolk & Western, has been transferred to the position of boilermaker foreman at Williamson, W. Va., succeeding W. D. Cassidy.

W. D. CASSIDY, boilermaker foreman of the Norfolk & Western at Williamson, W. Va., has been transferred to the position of night boilermaker foreman at Bluefield, W. Va., succeeding O. E. Chapman, deceased.

### Purchasing and Stores

H. C. YOUNG, assistant purchasing agent of the Delaware & Hudson, with headquarters at Albany, N. Y., has been appointed acting purchasing agent, with the same headquarters, replacing H. K. T. Sherwood, resigned.

### Obituary

FRANK R. FORREST, general foreman of the Norfolk & Western at Bluefield, W. Va., died on July 24.

J. BERTRAM YOUNG, engineer of tests of the Reading Company, died on July 29. Mr. Young was born on May 27, 1876. He became assistant chemist on the Reading on July 25, 1898; chemist, on July 1, 1906, and engineer of tests, on July 1, 1920.

M. A. KINNEY, former superintendent of motive power of the Hocking Valley and later general master mechanic of the Chesapeake & Ohio, with headquarters at Columbus, Ohio, whose death on July 16 was announced in the August issue of the *Railway Mechanical Engineer*, was born in Ashtabula county, Ohio, and first entered railway service on October 1, 1889 as a machinist apprentice on the Chicago, New York & St. Louis at Conneaut, Ohio. Mr. Kinney subsequently served the Nickel Plate as air-brake inspector, gang foreman at the Chicago shops, machine shop foreman and enginehouse foreman at Ft. Wayne, Ind. In February, 1904, he went with the Baltimore & Ohio as general enginehouse foreman at Newark, Ohio. In April, 1907, he become general foreman of the Mound Street shops of the Hocking Valley at Columbus. Later in 1907 he was appointed master mechanic, and on September 10, 1910, became superintendent of motive power. Mr. Kinney was appointed general master mechanic of the Chesapeake & Ohio with jurisdiction over the Hocking and Chicago divisions on May 1, 1930, following the acquisition of the Hocking Valley by the C. & O.